Sub-attachment A.5.1

Cell 1

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The following information is provided in this sub-attachment:

- Quarterly monitoring summary statistics (refer to Table A.5.1–1)
- Annual LCS sample summary information for detected parameters (refer to Table A.5.1–2)
- LCS monthly accumulation volumes (refer to Figure A.5.1–1)
- LDS monthly accumulation volumes (refer to Figure A.5.1–2)
- OSDF horizontal till well 12338 water yield (refer to Figure A.5.1–3)
- GMA water levels and uranium concentration versus time (refer to Figures A.5.1–4 and A.5.1–5)
- Plots of concentration versus time (refer to Figures A.5.1–6A to A.5.1–28B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.1–29)
- Control charts (refer to Figures A.5.1–30 to A.5.1–39)

A.5.1.1 Quarterly Monitoring Results

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within the cell is sampled in the LCS and LDS. Water quality beneath the cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present the results.

In 2012, 23 parameters were sampled quarterly in the LCS, LDS, and GMA wells of each cell. HTWs in all cells were sampled quarterly for arsenic, uranium, sodium, and sulfate. The LDS of Cell 1 was dry all year.

As shown in Table A.5.1–1, and summarized below, four parameters (uranium, arsenic, boron, and selenium) have upward trends in the HTW and/or the GMA wells based on the Mann-Kendall test for trend.

Parameters with upward concentration trends in the HTW and GMA Wells of Cell 1

Parameter	HTW[a] 12338	GMA-U[a] 22201	GMA-D[a] 22198
Uranium	Up	Up	Up
Arsenic			Up
Boron		Up	
Selenium		Up	Up

[a] HTW = horizontal till well, GMA-U = upgradient Great Miami Aquifer, GMA-D = downgradient Great Miami Aquifer.
No entry indicates that the trend was not up.

The (uranium-sodium) bivariate plot for the Cell 1 LCS, LDS, and HTW is provided in Figure A.5.1–29. The plot shows that the chemical signature for uranium-sodium in the LCS LDS, and HTW are separate and distinct; indicating that mixing between the horizons is not occurring. Therefore, upward concentration trends measured beneath Cell 1 (i.e., in the HTW

and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

A.5.1.2 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background. The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 2009) defines the process of creating a Shewart-CUSUM control chart. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected, the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared "out of control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit. Usually, two parameters are used to compute standardized limits; the decision value (h) and the SCL.

A minimum of eight samples are recommended for use in ChemStat software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat software plots both a CUSUM control limit (h) and a SCL on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL.

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat software though, by default, plots both the SCL and CUSUM (h) control limit on the charts. As a "work-a-round," the SCL limit was defined as 5 to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

As shown in Table A.5.1–1 in gray shading, eight parameters in the HTW and GMA wells of Cell 1 meet the criteria for control charts (i.e., more than eight samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 10 control charts.

These eleven control charts are presented in Figures A.5.1–30 to A.5.1–39. All of the control charts for Cell 1 indicate "in control" conditions.

Parameter and Monitoring Point[a]	Assessment	Figure Number
TDS in the GMA-U	In Control	A.5.1–30
TDS in the GMA-D	In Control	A.5.1–31
Barium in the GMA-U	In Control	A.5.1–32
Iron in the GMA-U	In Control	A.5.1–33
Lithium in the GMA-U	In Control	A.5.1–34
Lithium in the GMA-D	In Control	A.5.1–35
Manganese in the GMA-U	In Control	A.5.1–36
Nickel in the GMA-U	In Control	A.5.1–37
Copper in the GMA-D	In Control	A.5.1–38
Zinc in the GMA-U	In Control	A.5.1–39

[a] TDS = total dissolved solids; GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer

A.5.1.3 Annual LCS Sample Results

Annual LCS sampling results for Cell 1 are provided in Table A.5.1–2 for those parameters that have been detected at least once and are not being sampled quarterly. No new Appendix I or PCB parameters were detected in the LCS of Cell 1 in 2012.

A.5.1.4 Summary and Conclusions

- Four parameters have an upward concentration trend beneath Cell 1 in the HTW and/or GMA wells: uranium, arsenic, boron, and selenium.
- Separate and distinct chemical signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 1 indicate that water is not mixing between the horizons. Therefore, upward concentration trends beneath Cell 1 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell and not to cell performance.
- Ten control charts were constructed for Cell 1 parameters for monitoring horizons beneath the facility (HTW and GMA Wells). All of the control charts exhibit “in control” conditions.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 1 in 2012.

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Table A.5.1–1. Summary Statistics for Cell 1

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Total Uranium (µg/L)	LCS	12338C	57	58	98.3	ND	206	81.1	37.1	Normal	Up	Detected	
	LDS	12338D	37	37	100	1.5	37	10.8	6.8	Undefined	Up	Detected	
	HTW	12338	58	60	96.7	ND	19	6.47	4.21	Undefined	Up	Detected	
	GMA-U	22201	59	63	93.6	ND	11.2	3.28	3.01	Undefined	Up	Detected	
	GMA-D	22198	63	63	100	0.574	15.2	5.00	2.89	Undefined	Up	Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12338C	27	27	100	227	721	406	144	LogNormal	Down	Not Detected	
	LDS	12338D	7	7	100	206	528	362	109	Normal	None	Not Detected	
	GMA-U	22201	8	8	100	420	563	506	54	Normal	None	Not Detected	
	GMA-D	22198	8	8	100	224	383	361	62	Undefined	None	Not Detected	
Chloride (mg/L)	LCS	12338C	27	27	100	21.8	55	39.4	6.9	Undefined	Up	Detected	
	LDS	12338D	7	7	100	87.1	202	128	38	Normal	None	Not Detected	
	GMA-U	22201	8	8	100	32.6	75	38.3	13.5	Undefined	None	Not Detected	
	GMA-D	22198	8	8	100	20.2	27.3	22.7	2.1	Normal	None	Not Detected	
Nitrate, Nitrite (mg/L)	LCS	12338C	26	38	68.4	ND	49	0.775	18.9	Undefined	None	Detected	
	LDS	12338D	5	10	50.0	ND	359	0.054	113	Undefined	None	Not Detected	
	GMA-U	22201	4	8	50.0	ND	0.361	0.134	0.132	Normal	None	Not Detected	
	GMA-D	22198	8	28	28.6	ND	0.55	0.040	0.216	Undefined	None	Detected	
Sulfate (mg/L)	LCS	12338C	44	44	100	707	2510	1460	61	Undefined	Up	Detected	
	LDS	12338D	19	19	100	675	3500	1850	78	LogNormal	Up	Detected	
	HTW	12338	34	34	100	497	907	694	105	Normal	Down	Detected	
	GMA-U	22201	39	39	100	91.8	1980	307	310	LogNormal	None	Detected	
	GMA-D	22198	39	39	100	101	506	218	103	LogNormal	Down	Not Detected	
Total Dissolved Solids (mg/L)	LCS	12338C	37	37	100	1790	5200	2560	930	Undefined	Up	Detected	
	LDS	12338D	6	6	100	2430	7540	5160	2000	Normal	None	Not Detected	
	GMA-U	22201	15	15	100	804	1260	1010	140	Normal	None	Not Detected	
	GMA-D	22198	15	15	100	577	805	677	74	Normal	None	Not Detected	
Total Organic Carbon (mg/L)	LCS	12338C	56	58	96.6	ND	123	18.6	16.4	Undefined	Down	Detected	
	LDS	12338D	34	38	89.5	ND	80.9	7.09	12.4	Undefined	None	Not Detected	
	GMA-U	22201	50	63	79.4	ND	17.6	2.49	3.45	Undefined	None	Not Detected	59.7(Q2-98)
	GMA-D	22198	44	62	71.0	ND	15.8	1.45	2.69	Undefined	None	Not Detected	52.5(Q2-98)
Total Organic Halogens (mg/L)	LCS	12338C	54	59	91.5	ND	1.52	0.185	0.224	Undefined	None	Detected	
	LDS	12338D	28	38	73.7	ND	0.361	0.0527	0.0587	LogNormal	None	Not Detected	
	GMA-U	22201	25	63	39.7	ND	0.078	0.00764	0.0114	Undefined	Down	Not Detected	0.308(Q2-00)
	GMA-D	22198	11	62	17.7	ND	0.1	0.0032	0.0177	Undefined	Down	Detected	
Arsenic (mg/L)	LCS	12338C	11	32	34.4	ND	0.0786	0.00670	0.0138	LogNormal	None	Not Detected	
	LDS	12338D	1	9	11.1	ND	0.0125	Insufficient	Insufficient	LogNormal	None	Not Detected	
	HTW	12338	3	24	12.5	ND	0.0607	0.0025	Insufficient	Undefined	None	Not Detected	
	GMA-U	22201	3	15	20.0	ND	0.04	0.0025	Insufficient	Undefined	None	Not Detected	
	GMA-D	22198	7	48	14.6	ND	0.0372	0.0020	0.0075	Undefined	Up	Detected	
Barium (mg/L)	LCS	12338C	27	27	100	0.0241	0.205	0.0735	0.0474	Normal	Down	Detected	
	LDS	12338D	7	7	100	0.0146	0.0173	0.0156	0.0010	Normal	None	Not Detected	
	GMA-U	22201	9	9	100	0.0399	0.124	0.0786	0.0235	Normal	None	Not Detected	
	GMA-D	22198	10	10	100	0.0562	0.138	0.0683	0.0230	Undefined	None	Not Detected	

Table A.5.1−1 (continued). Summary Statistics for Cell 1

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Boron (mg/L)	LCS	12338C	58	59	98.3	ND	2.81	1.02	0.52	Undefined	None	Detected	
	LDS	12338D	37	38	97.4	ND	0.345	0.231	0.066	Undefined	None	Not Detected	
	GMA-U	22201	61	63	96.8	ND	0.158	0.114	0.028	Normal	Up	Detected	
	GMA-D	22198	58	62	93.6	ND	0.131	0.0590	0.0169	Undefined	None	Detected	
Calcium (mg/L)	LCS	12338C	27	27	100	377	1500	527	227	Undefined	None	Not Detected	
	LDS	12338D	7	7	100	324	553	396	78	Normal	Up	Not Detected	
	GMA-U	22201	8	8	100	170	271	225	35	Normal	None	Not Detected	
	GMA-D	22198	8	8	100	137	192	166	18	Normal	None	Not Detected	
Cobalt (mg/L)	LCS	12338C	17	32	53.1	ND	0.0575	0.00228	0.0137	Undefined	Down	Detected	
	LDS	12338D	6	9	66.7	ND	0.0019	0.0011	0.0005	Normal	None	Not Detected	
	GMA-U	22201	4	15	26.7	ND	0.00223	0.0005	0.0006	Undefined	None	Not Detected	
	GMA-D	22198	6	35	17.1	ND	0.0045	0.0005	0.0009	Undefined	None	Not Detected	
Copper (mg/L)	LCS	12338C	22	28	78.6	ND	0.0285	0.0104	0.0069	Normal	None	Not Detected	
	LDS	12338D	6	8	75.0	ND	0.0231	0.0098	0.0070	Normal	None	Not Detected	
	GMA-U	22201	6	8	75.0	ND	0.011	0.0055	0.0043	Normal	None	Not Detected	
	GMA-D	22198	6	9	66.7	ND	0.0104	0.0041	0.0039	Normal	None	Not Detected	
Iron (mg/L)	LCS	12338C	29	32	90.6	ND	101	14.0	18.3	LogNormal	Down	Detected	
	LDS	12338D	7	9	77.8	ND	2.55	1.30	1.00	Normal	None	Detected	
	GMA-U	22201	15	15	100	0.0479	4.42	2.30	1.64	LogNormal	None	Not Detected	
	GMA-D	22198	28	28	100	0.531	6.92	2.96	1.55	Undefined	Down	Detected	
Lithium (mg/L)	LCS	12338C	24	24	100	0.103	0.232	0.148	0.035	Normal	Up	Detected	
	LDS	12338D	9	9	100	0.0333	0.075	0.0561	0.0137	Normal	None	Not Detected	
	GMA-U	22201	15	15	100	0.00723	0.0153	0.0111	0.0027	Normal	None	Not Detected	
	GMA-D	22198	15	15	100	0.00799	0.0107	0.0092	0.0008	Normal	None	Not Detected	
Magnesium (mg/L)	LCS	12338C	27	27	100	71.4	525	177	156	Undefined	Up	Detected	
	LDS	12338D	7	7	100	120	326	179	69	LogNormal	None	Not Detected	
	GMA-U	22201	8	8	100	36.1	54.7	46.1	5.6	Normal	None	Not Detected	
	GMA-D	22198	8	8	100	37.7	47.8	43.0	3.7	Normal	None	Not Detected	
Manganese (mg/L)	LCS	12338C	16	32	50	ND	7.7	0.0102	1.73	Undefined	Down	Detected	
	LDS	12338D	8	9	88.9	ND	0.184	0.0275	0.0579	LogNormal	Down	Not Detected	
	GMA-U	22201	17	17	100	0.0322	2.06	1.03	0.69	LogNormal	None	Not Detected	
	GMA-D	22198	47	48	97.9	ND	1.09	0.511	0.201	LogNormal	None	Detected	
Nickel (mg/L)	LCS	12338C	28	32	87.5	ND	0.0535	0.0136	0.0167	Undefined	Down	Detected	
	LDS	12338D	9	9	100	0.00486	0.0353	0.0169	0.0082	Normal	None	Not Detected	
	GMA-U	22201	14	15	93.3	ND	0.0115	0.0050	0.0027	Normal	None	Not Detected	
	GMA-D	22198	18	48	37.5	ND	0.13	0.0010	0.0186	Undefined	Down	Not Detected	
Potassium (mg/L)	LCS	12338C	27	27	100	10.8	30	21.1	5.5	Normal	Up	Detected	
	LDS	12338D	7	7	100	13.2	35.4	19.8	7.4	LogNormal	None	Not Detected	
	GMA-U	22201	8	8	100	2.28	3.97	3.28	0.56	Normal	None	Not Detected	
	GMA-D	22198	8	8	100	1.73	2.07	1.90	0.13	Normal	Down	Not Detected	

Table A.5.1−1 (continued). Summary Statistics for Cell 1

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Selenium (mg/L)	LCS	12338C	14	32	43.8	ND	0.0715	0.00944	0.0166	LogNormal	Up	Not Detected	
	LDS	12338D	1	9	11.1	ND	0.076	Insufficient	Insufficient	Undefined	Up	Not Detected	
	GMA-U	22201	0	15	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22198	4	35	11.4	ND	0.00758	0.0020	0.0014	Undefined	Up	Detected	
Sodium (mg/L)	LCS	12338C	32	32	100	11.7	29.3	18.1	3.6	Normal	Up	Detected	
	LDS	12338D	9	9	100	335	896	571	216	Normal	None	Not Detected	
	HTW	12338	24	24	100	10.2	23.8	16.0	3.8	Normal	Down	Detected	
	GMA-U	22201	15	15	100	45	65.5	59.1	8.0	Undefined	Down	Detected	
	GMA-D	22198	15	15	100	13	17.1	14.9	1.1	Normal	Down	Not Detected	
Zinc (mg/L)	LCS	12338C	19	32	59.4	ND	0.575	0.0742	0.138	Normal	None	Detected	
	LDS	12338D	9	9	100	0.0557	0.671	0.239	0.190	LogNormal	None	Not Detected	
	GMA-U	22201	8	15	53.3	ND	0.0127	0.0060	0.0039	Normal	None	Not Detected	
	GMA-D	22198	18	48	37.5	ND	0.0474	0.00442	0.00680	LogNormal	None	Detected	

Note 1: Shading identifies a horizontal till well or Great Miami Aquifer well, with more than 8 samples, normal or lognormal distribution, no trend, and no serial correlation. These wells achieve control chart criteria.

Note 2: Data used in this table has been standardized to quarterly.

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]ND = not detected; NA = not applicable

[c]Averages were determined based on the distribution assumption.

[d]Insufficient is used for Distribution Type, Trend, or Serial Correlation whenever there is not enough data to run the test.

[e]Data distribution based on the Shapiro-Wilk statistic.

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[f]Trend based on nonparametric Mann-Kendall procedure.

[g]Serial correlation based on Rank Von Neumann test.

[h]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 25).

[i]Q = quarterly

Table A.5.1–2. Cell 1 Annual LCS Sample Summary Information for Detected Parameters

PARAMETER (UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	DETECTED IN 2012	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (SAMPLES>GW BACKGROUND)	PW BACKGROUND[a,b,e] (SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (SAMPLES>MAX PW)
General Chemistry											
Ammonia (mg/L)	15	11	73.3	Yes	0.03	4.5	0.732	-	4.2 mg/L(1)	4.34 mg/L(1)	220 mg/L(0)
Inorganic											
Beryllium (mg/L)	15	2	13.3	No	0.0000674	0.00012	0.0001	0.004 mg/L(0)	-	-	0.0343 mg/L(0)
Cadmium (mg/L)	15	4	26.7	No	0.00014	0.00084	0.0004	0.014 mg/L(0)	0.014 mg/L(0)	-	0.05 mg/L(0)
Chromium (mg/L)	15	6	40.0	No	0.0012	0.00365	0.0023	0.022 mg/L[g](0)	0.021 mg/L(0)	0.0046 mg/L(0)	0.818 mg/L(0)
Lead (mg/L)	15	2	13.3	No	0.00066	0.0222	0.0114	0.015 mg/L(1)	0.022 mg/L(1)	0.0016 mg/L(1)	0.0114 mg/L(1)
Mercury (mg/L)	29	2	6.9	No	0.00000024	0.00047	0.0002	0.002 mg/L(0)	-	-	0.0018 mg/L(0)
Silver (mg/L)	15	1	6.7	No	0.00014	-	-	0.05 mg/L(0)	0.0117 mg/L(0)	0.0031 mg/L(0)	0.264 mg/L(0)
Thallium (mg/L)	15	2	13.3	No	0.0007	0.00756	0.0041	-	-	-	0.0028 mg/L(1)
Radionuclide											
Technetium-99 (pCi/L)	31	7	22.6	No	1.81	18.3	9.92	94 pCi/L(0)	22 pCi/L(0)	30 pCi/L(0)	6130 pCi/L(0)
Organic											
4-Nitroaniline (ug/L)	28	1	3.6	No	1.01	-	-	-	-	-	-

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information.

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on hexavalent chromium from Operable Unit 5 Record of Decision, Table 9-4.

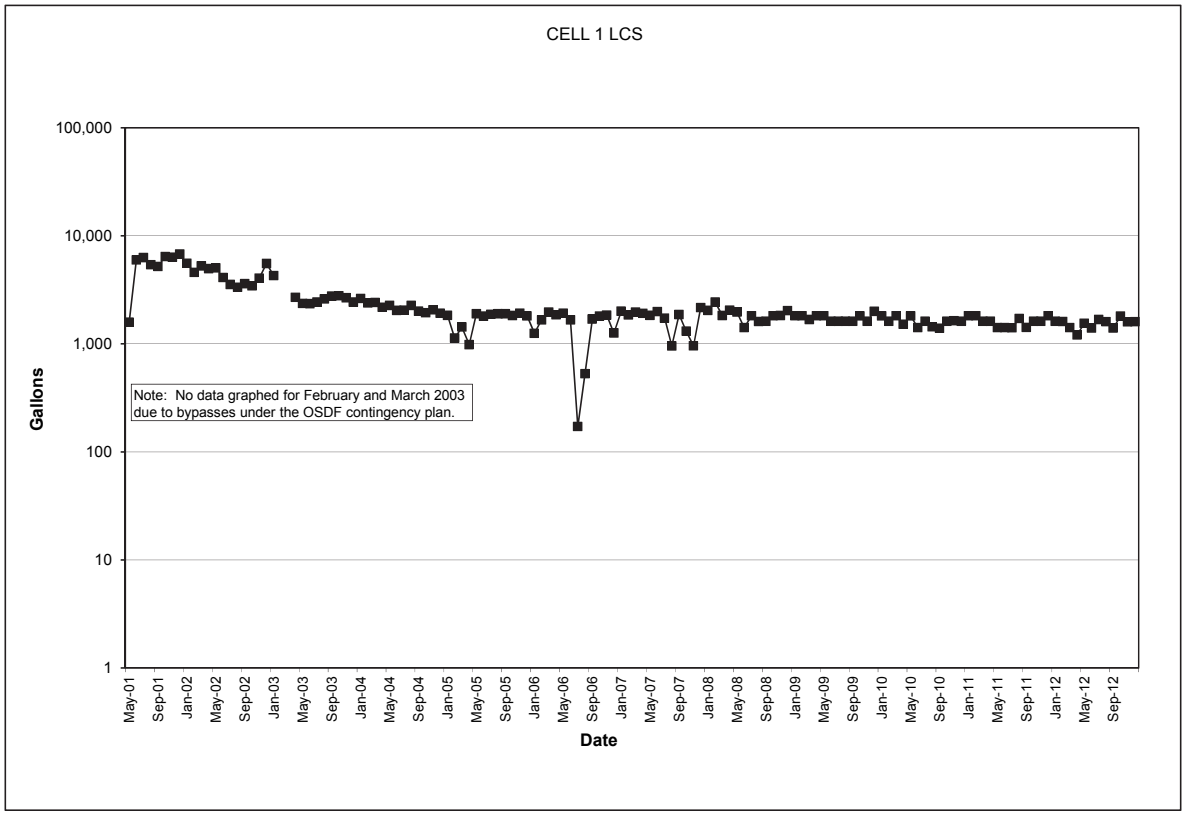


Figure A.5.1–1. Monthly Accumulation Volumes For Cell 1 LCS

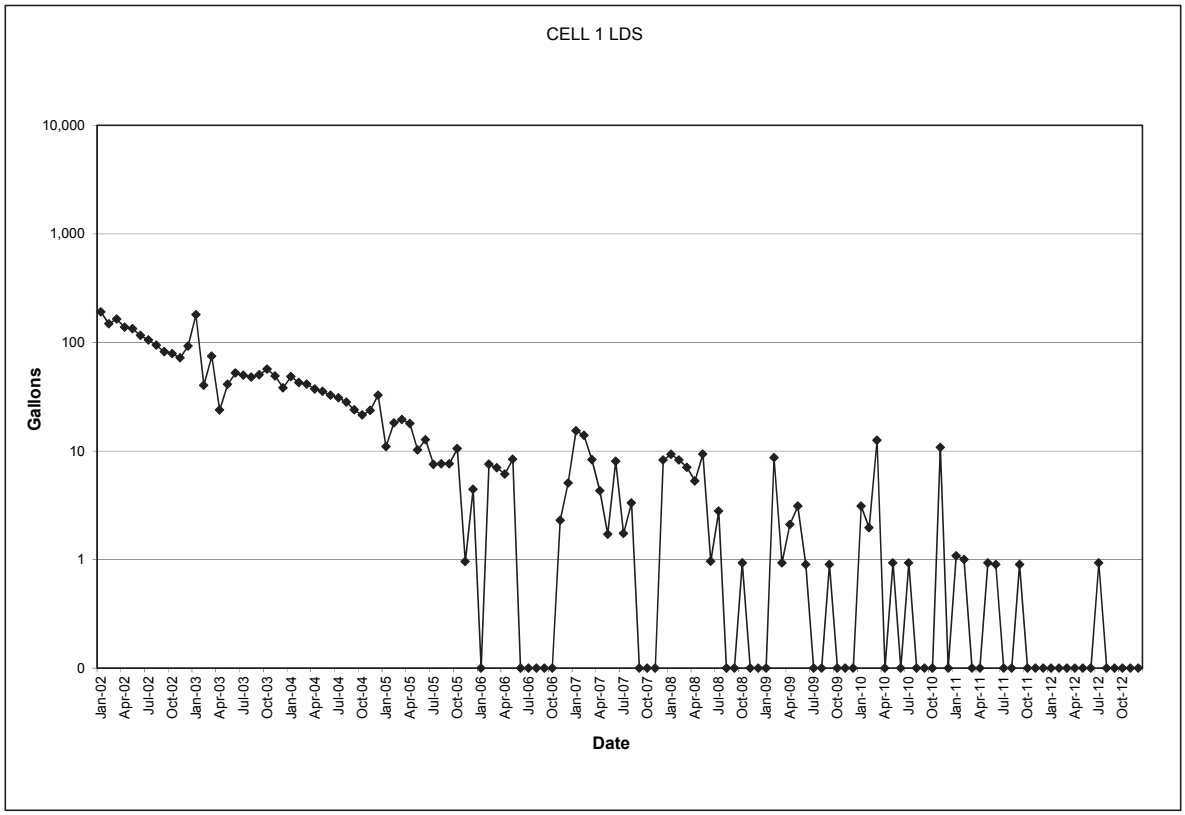
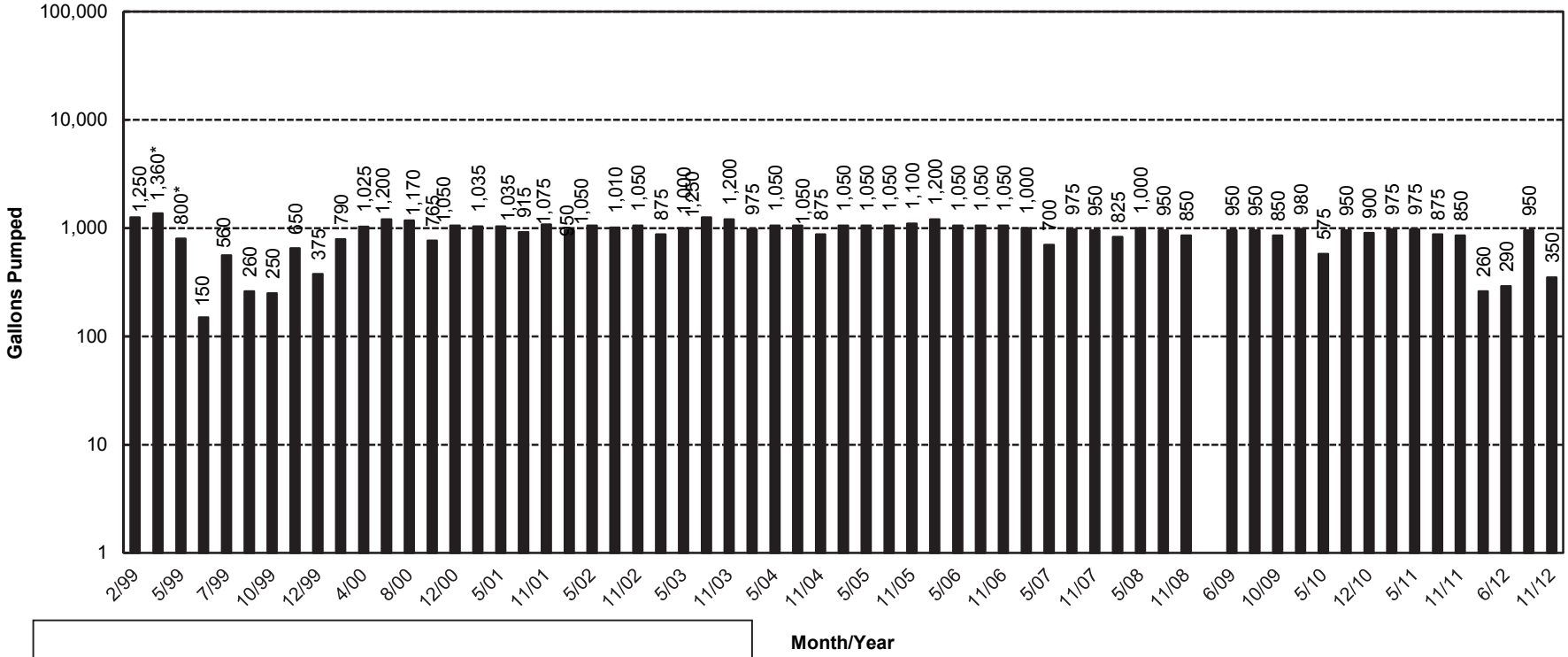


Figure A.5.1–2. Monthly Accumulation Volumes For Cell 1 LDS



12338 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
1999:	5655	n=9	628
2000:	6000	n=6	1000
2001:	4060	n=4	1015
2002:	4060	n=4	1015
2003:	4325	n=4	1081
2004:	3950	n=4	988
2005:	4250	n=4	1063
2006:	4350	n=4	1088
2007:	3625	n=4	906
2008:	3625	n=4	906
2009:	2750	n=3	917
2010:	3405	n=4	851
2011:	3675	n=4	919
2012:	1850	n=4	463
Overall:			896

*More than one purge of the well was completed during these months to help evaluate well yield.

Figure A.5.1–3. OSDF Horizontal Till Well 12338 (Cell 1) Water Yield

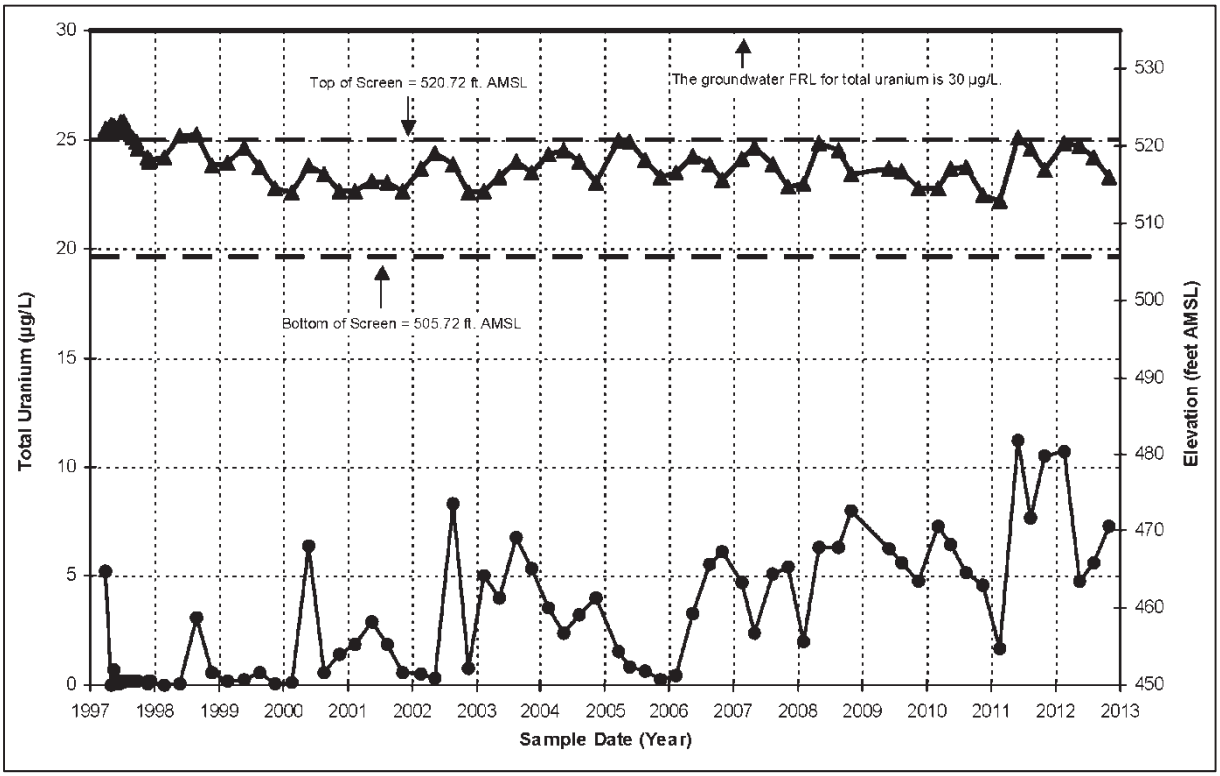


Figure A.5.1–4. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 1 Upgradient Monitoring Well 22201

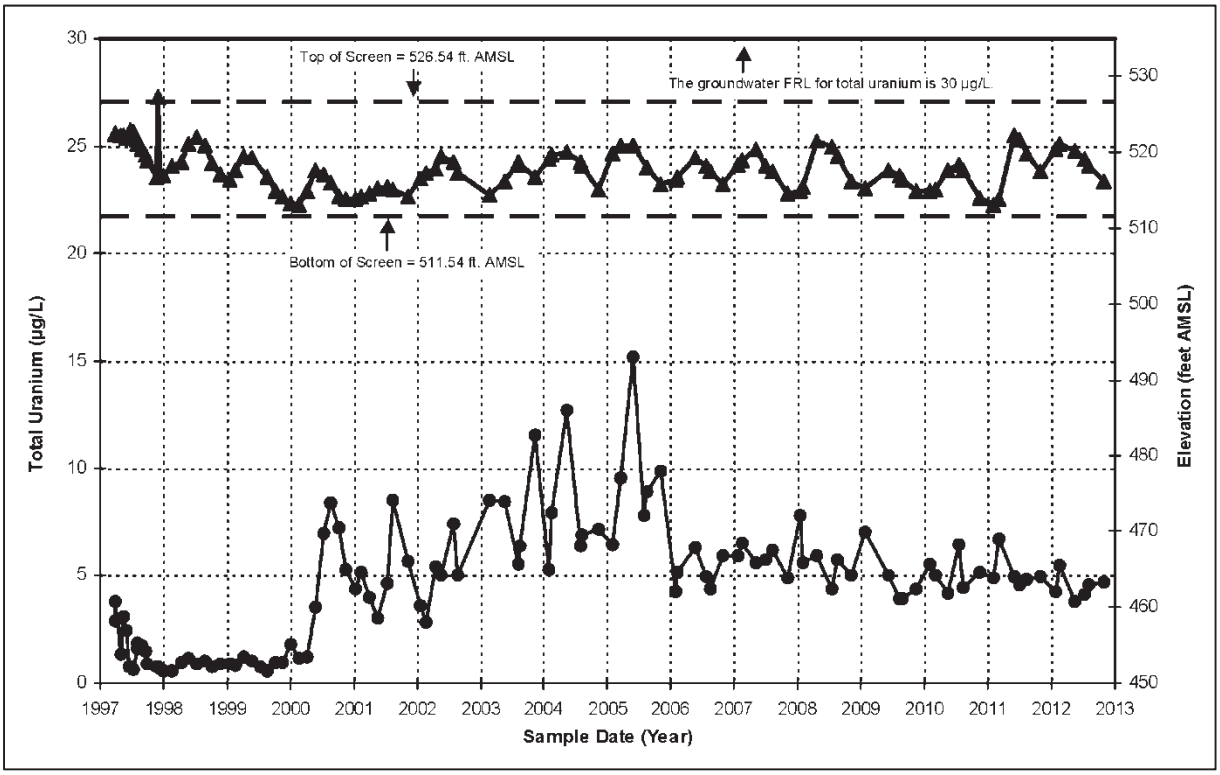


Figure A.5.1–5. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 1 Downgradient Monitoring Well 22198

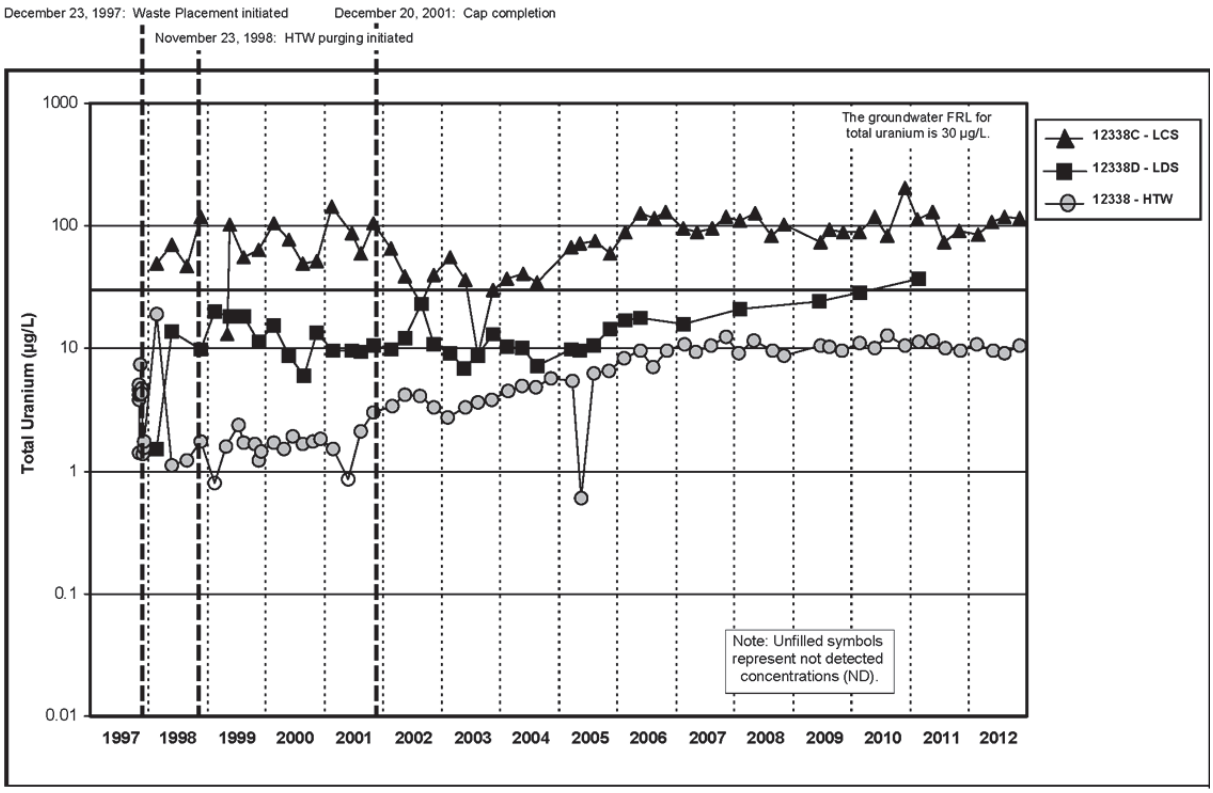


Figure A.5.1–6A. Cell 1 Total Uranium Concentration vs. Time Plot for LCS, LDS, and HTW

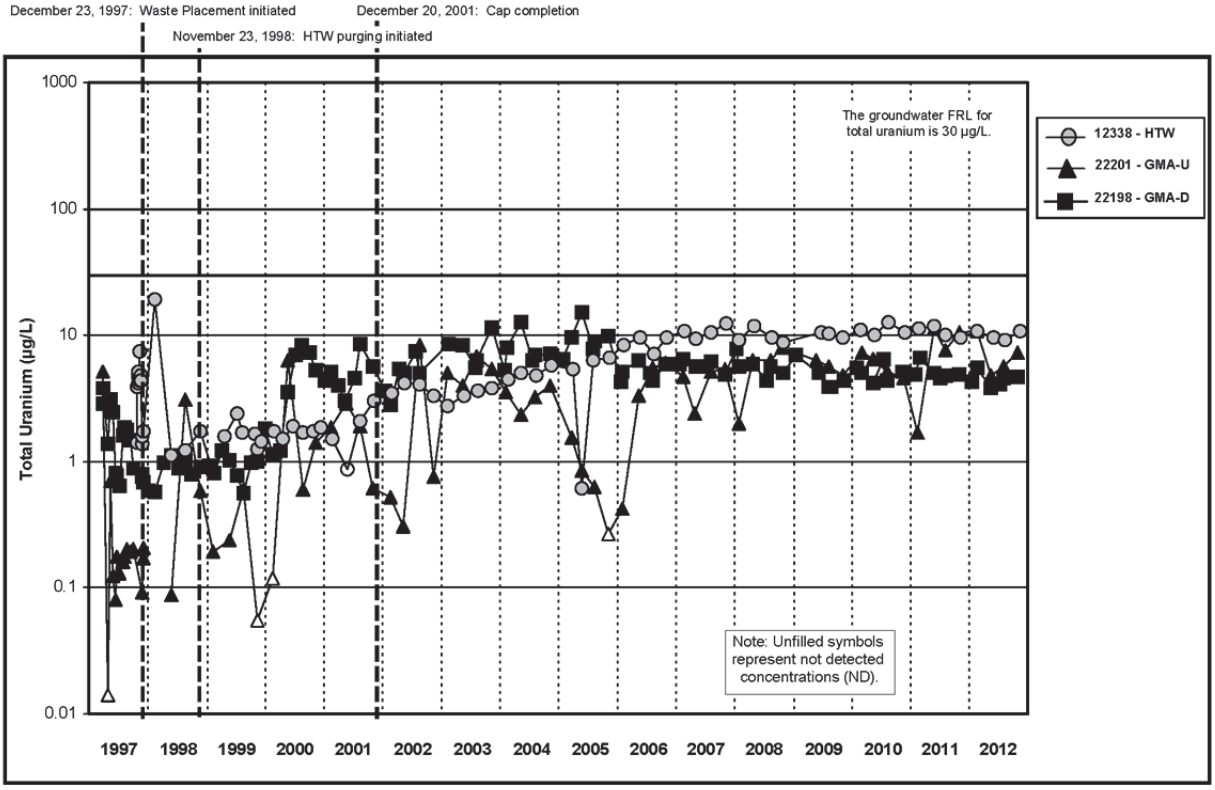


Figure A.5.1–6B. Cell 1 Total Uranium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

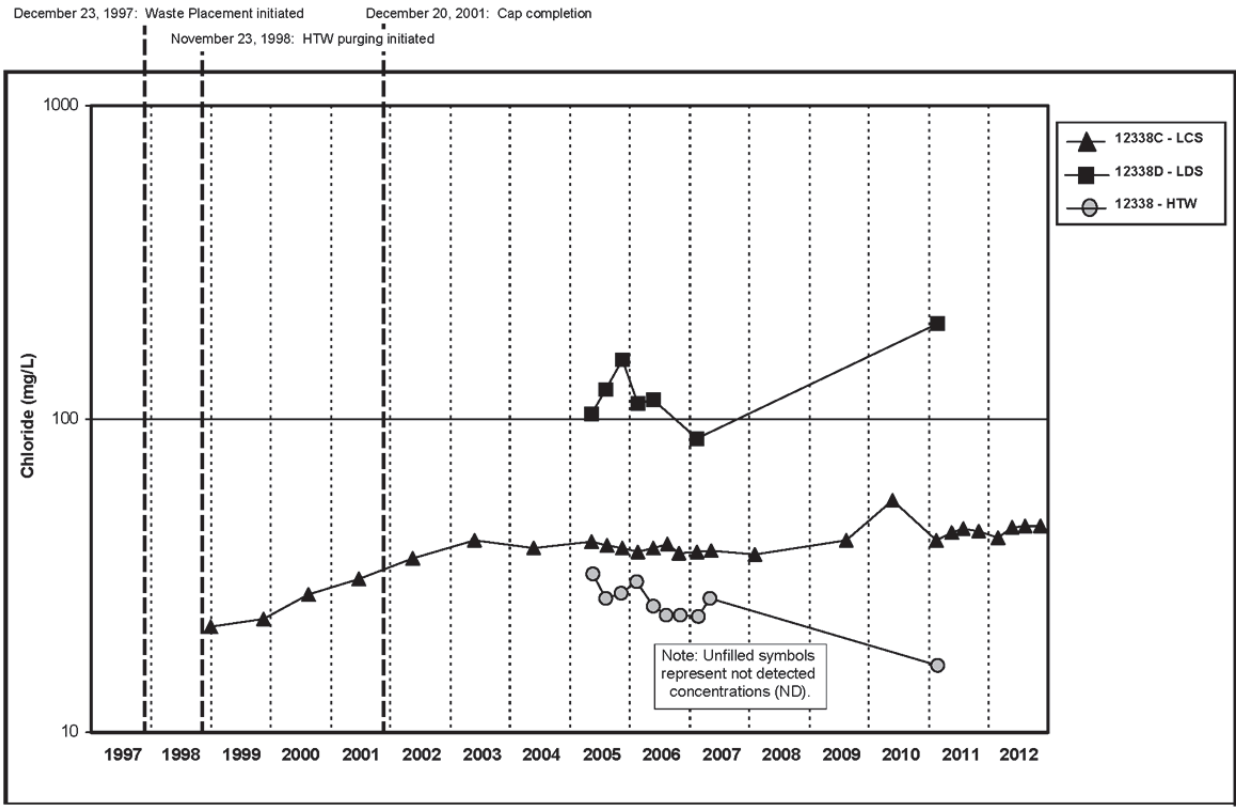


Figure A.5.1–7A. Cell 1 Chloride Concentration vs. Time Plot for LCS, LDS, and HTW

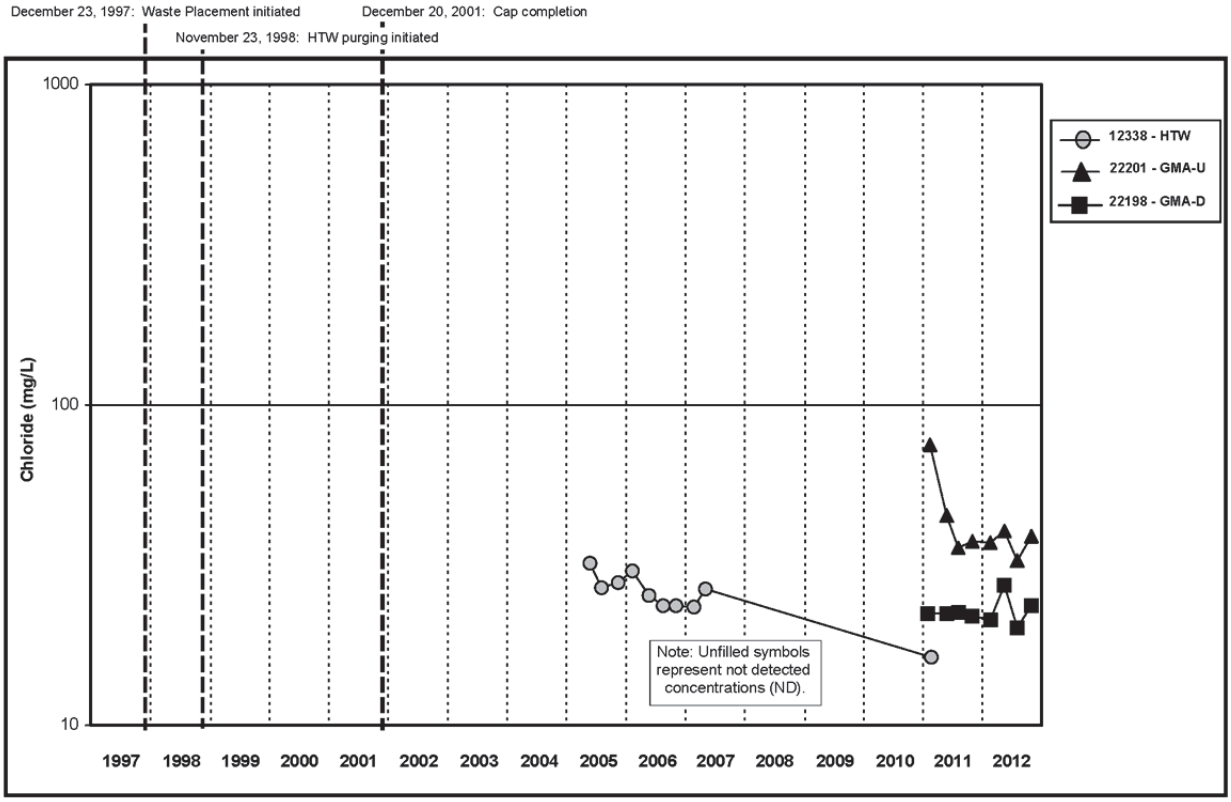


Figure A.5.1–7B. Cell 1 Chloride Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

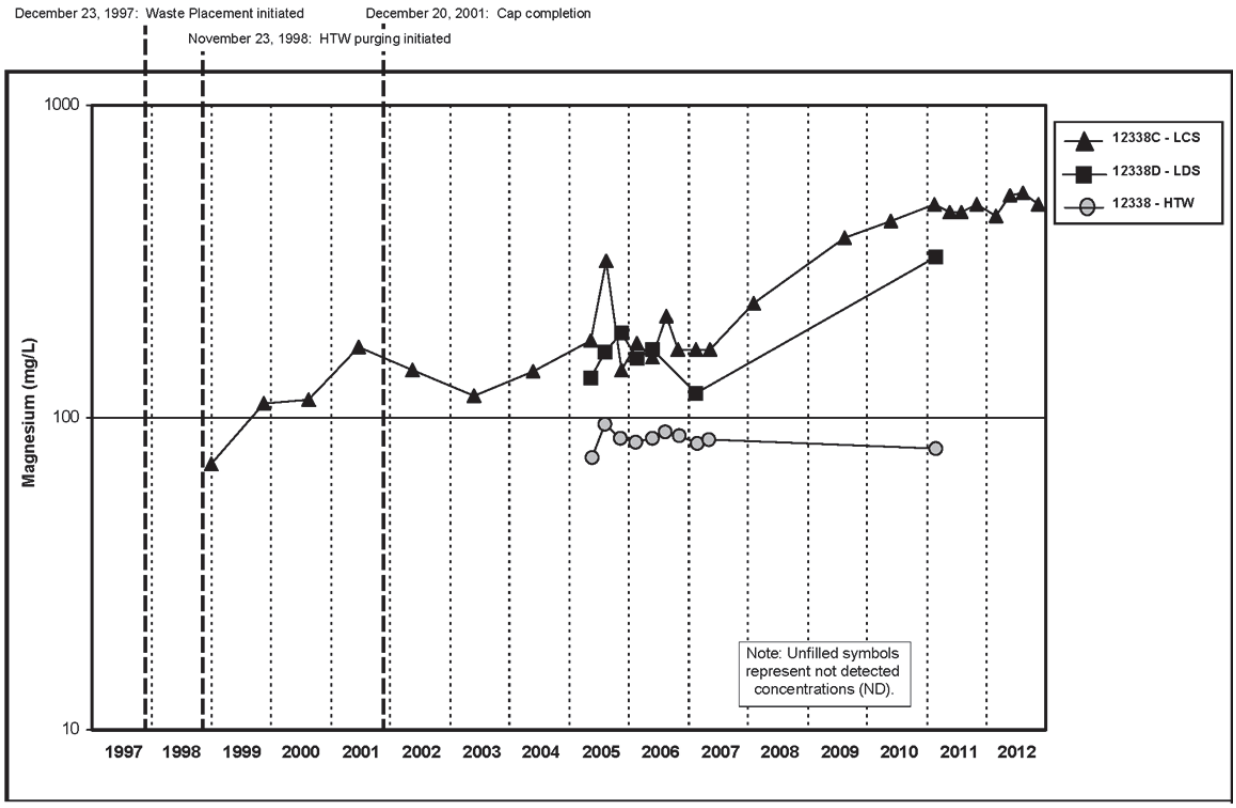


Figure A.5.1–8A. Cell 1 Magnesium Concentration vs. Time Plot for LCS, LDS, and HTW

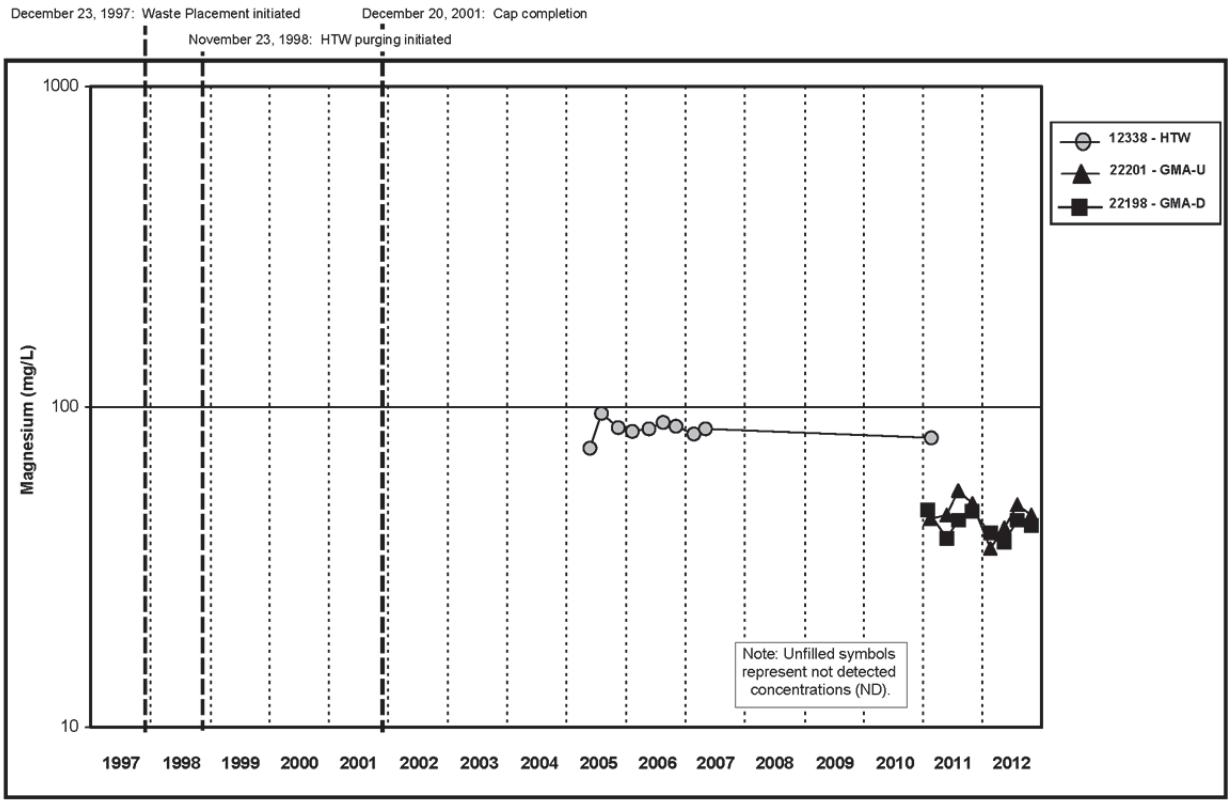


Figure A.5.1–8B. Cell 1 Magnesium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

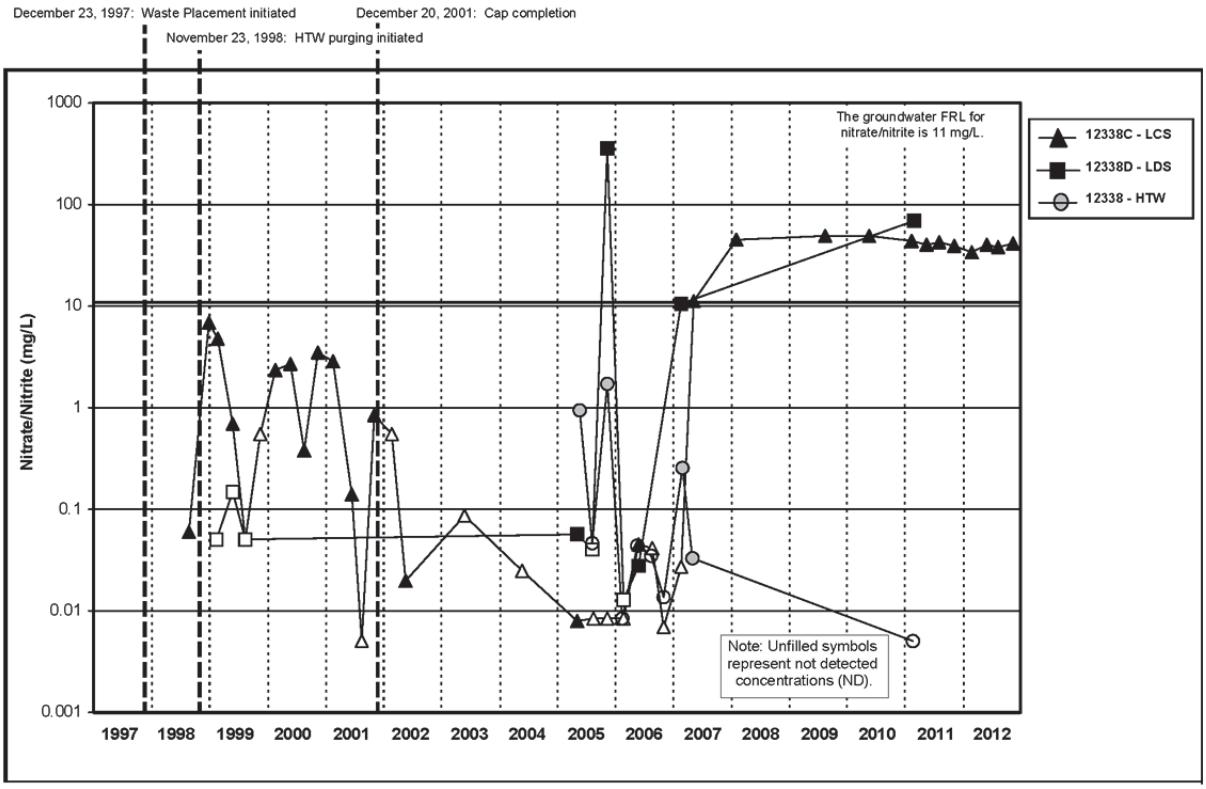


Figure A.5.1–9A. Cell 1 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for LCS, LDS, and HTW

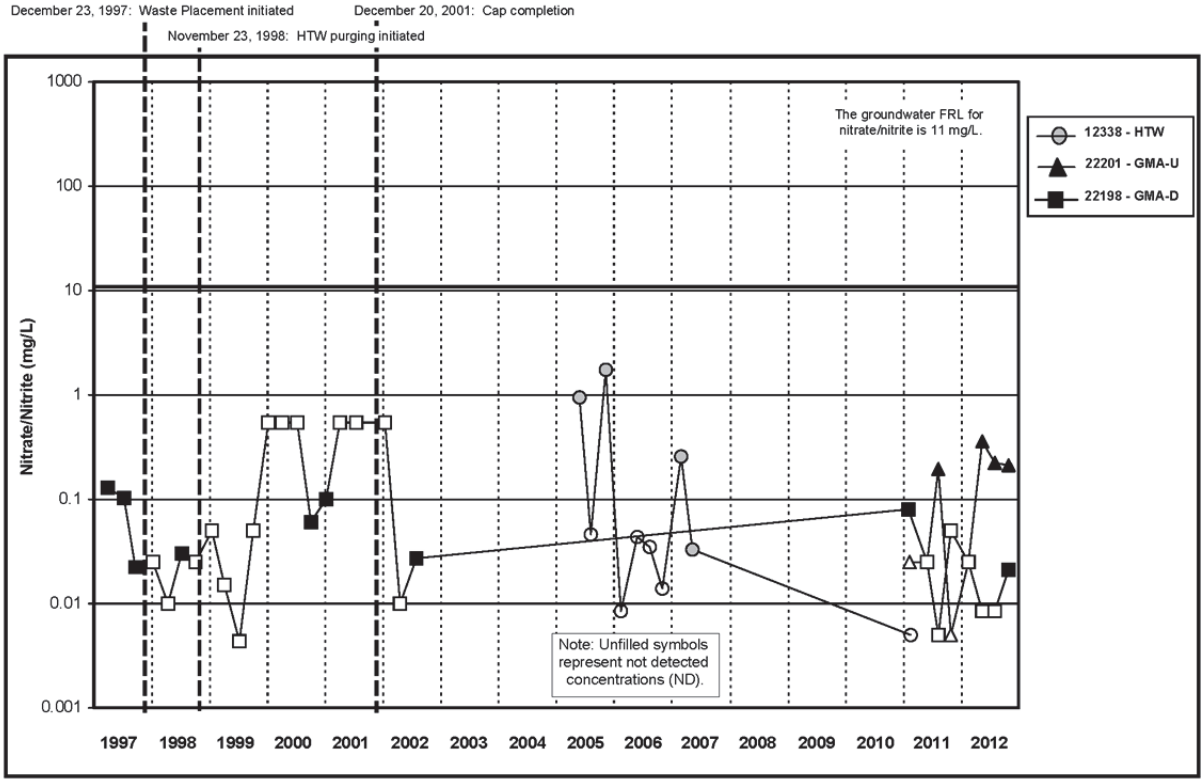


Figure A.5.1–9B. Cell 1 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

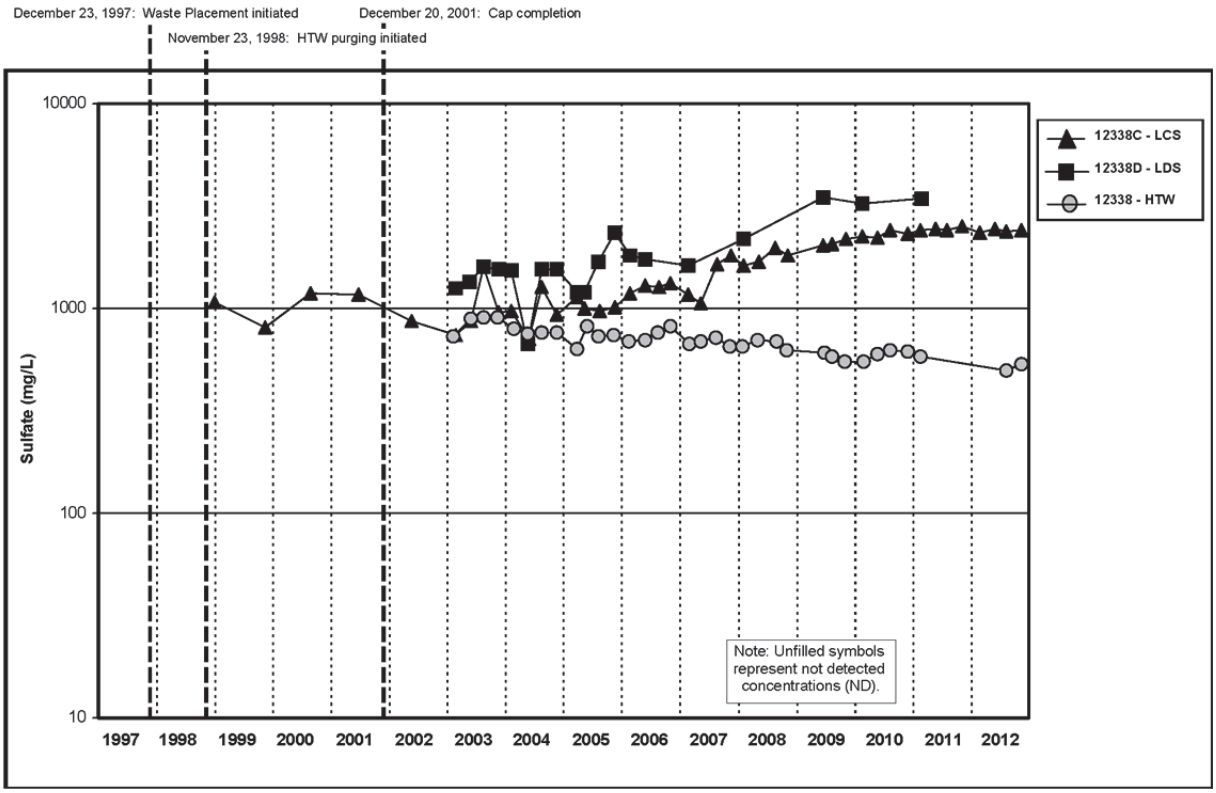


Figure A.5.1–10A. Cell 1 Sulfate Concentration vs. Time Plot for LCS, LDS, and HTW

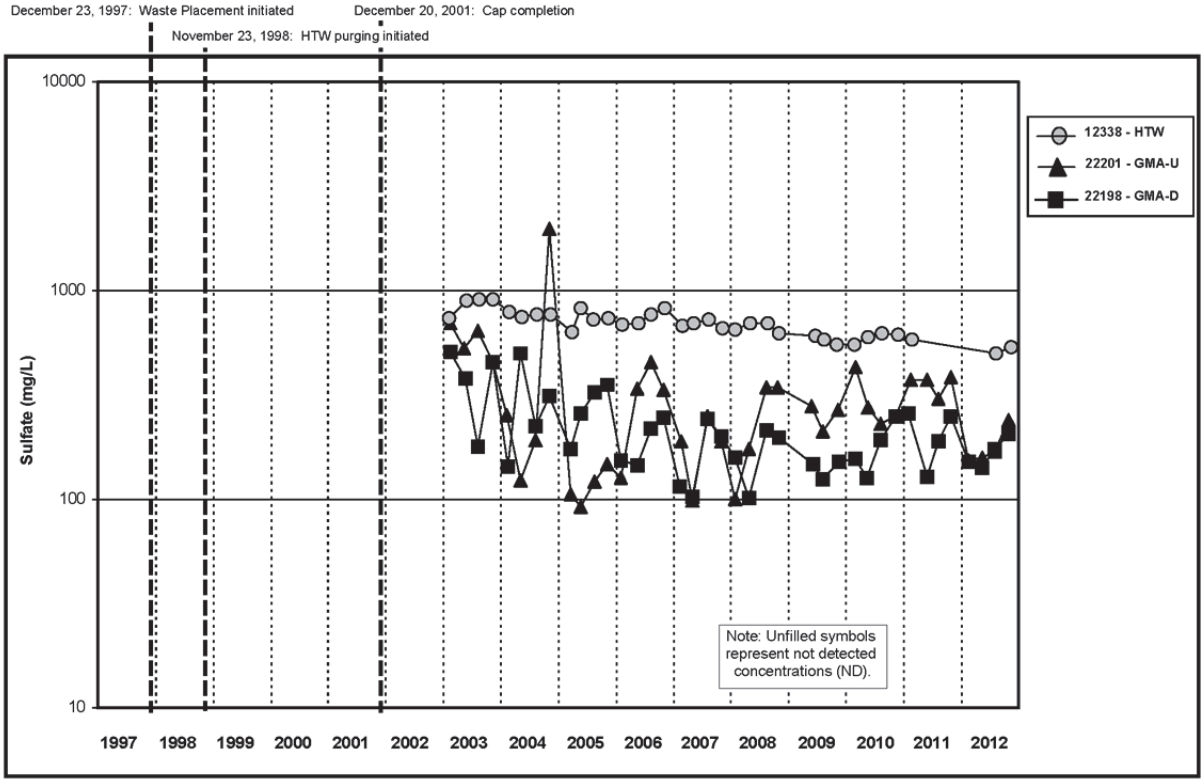


Figure A.5.1–10B. Cell 1 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

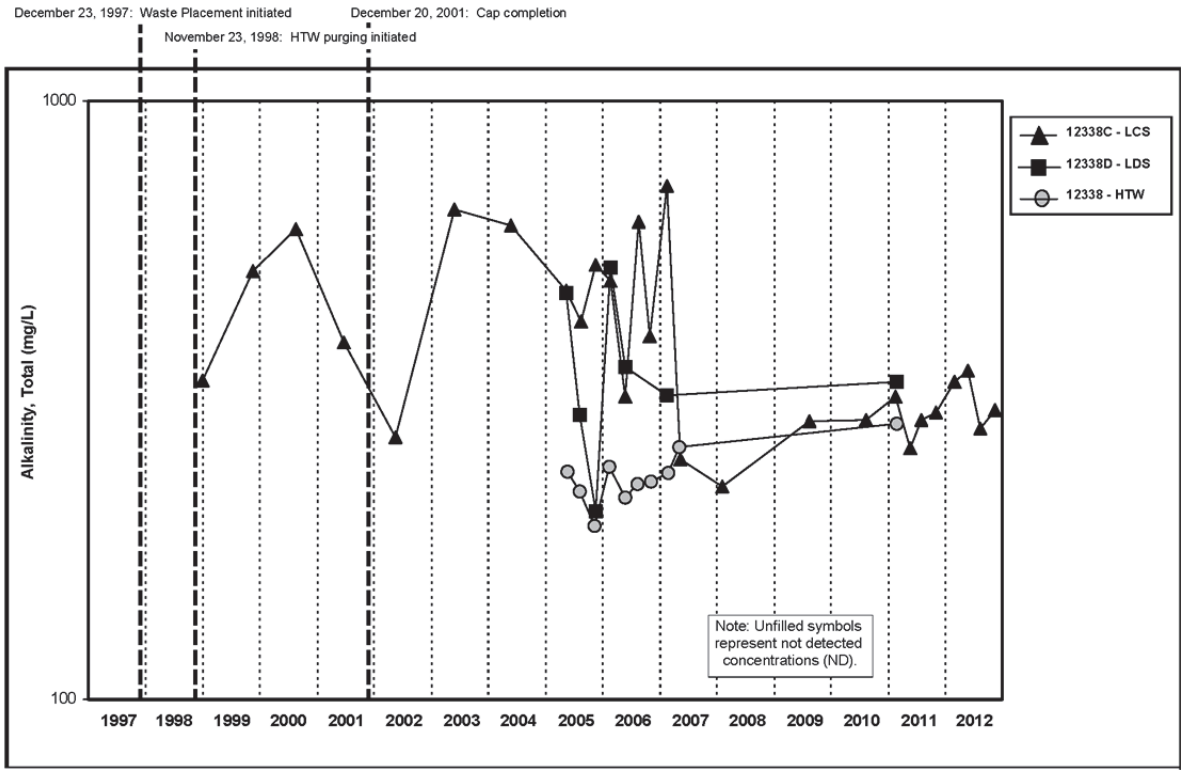


Figure A.5.1–11A. Cell 1 Alkalinity, Total (As $CaCO_3$) Concentration vs. Time Plot for LCS, LDS, and HTW

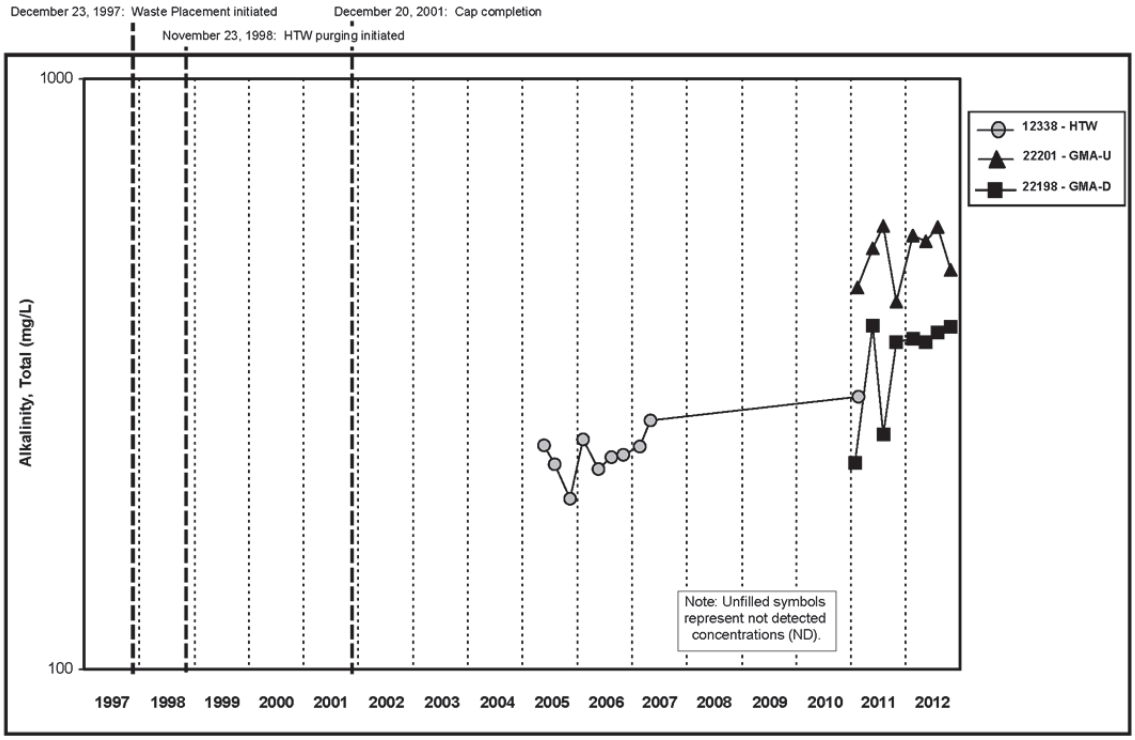


Figure A.5.1–11B. Cell 1 Alkalinity, Total (As $CaCO_3$) Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

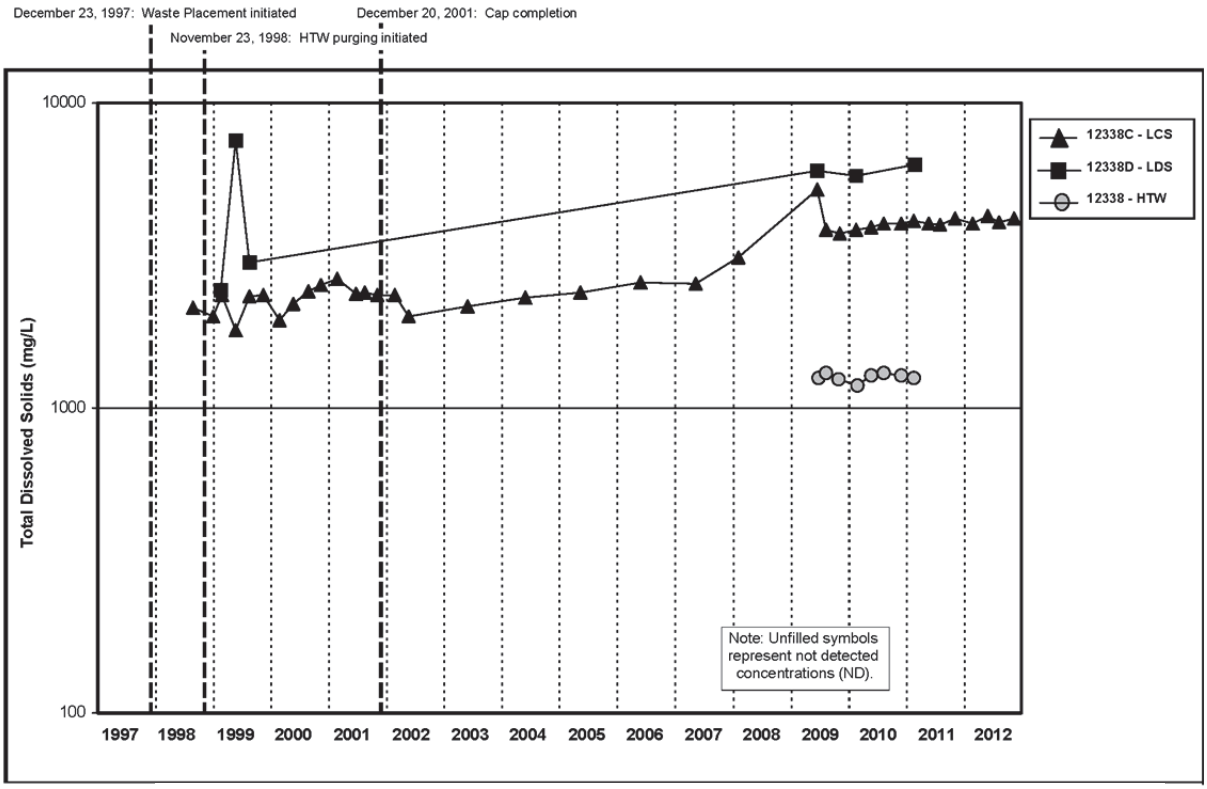


Figure A.5.1–12A. Cell 1 Total Dissolved Solids Concentration vs. Time Plot for LCS, LDS, and HTW

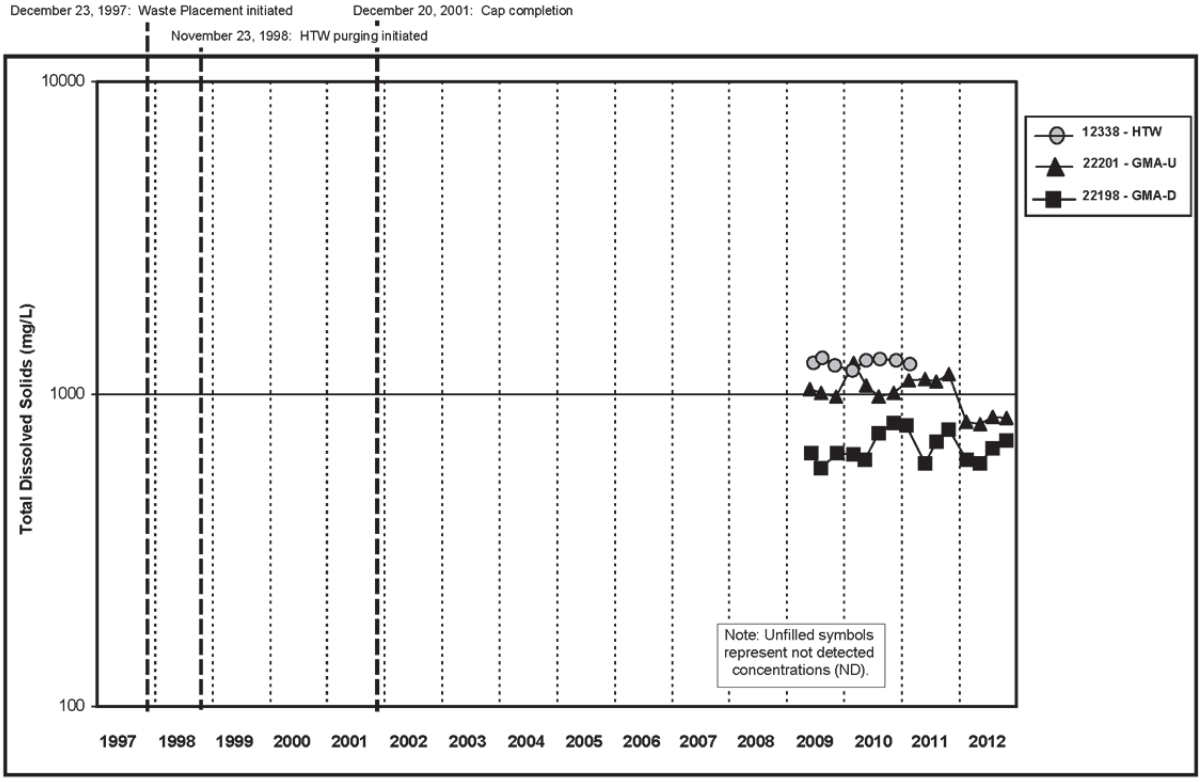


Figure A.5.1–12B. Cell 1 Total Dissolved Solids Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

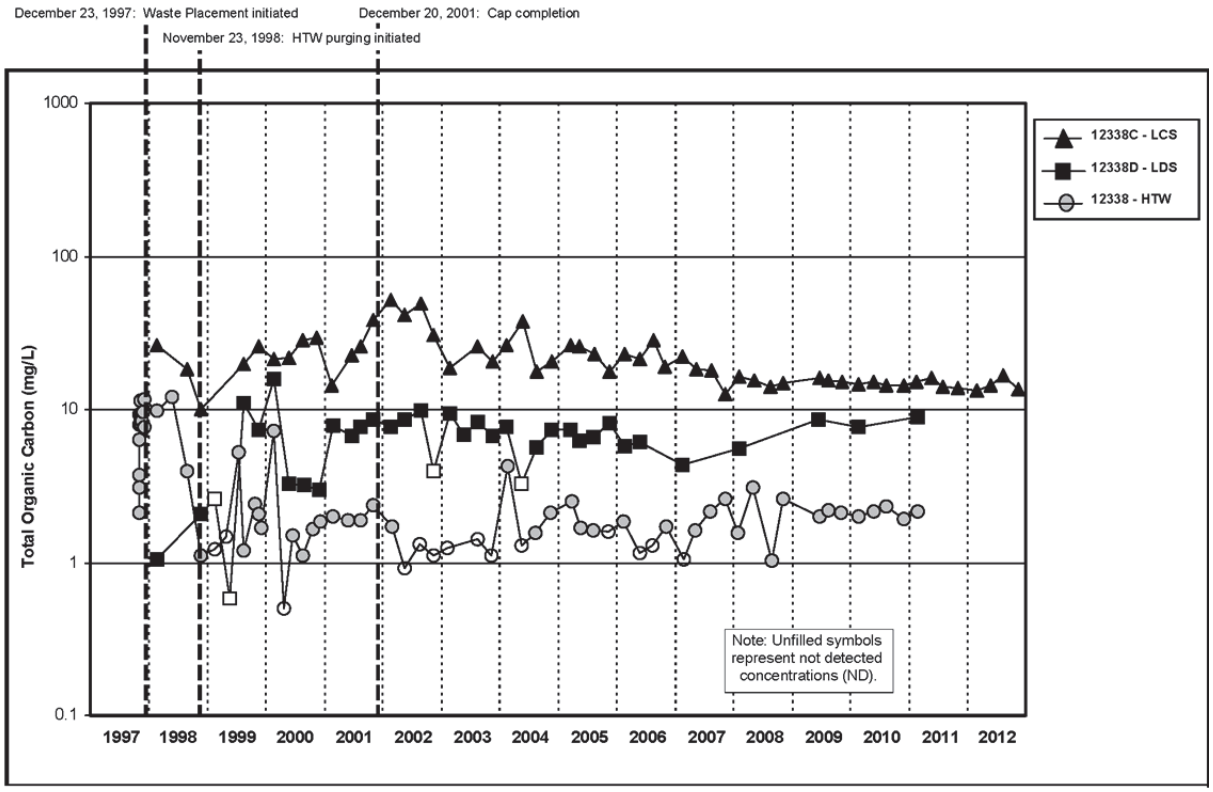


Figure A.5.1–13A. Cell 1 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, and HTW

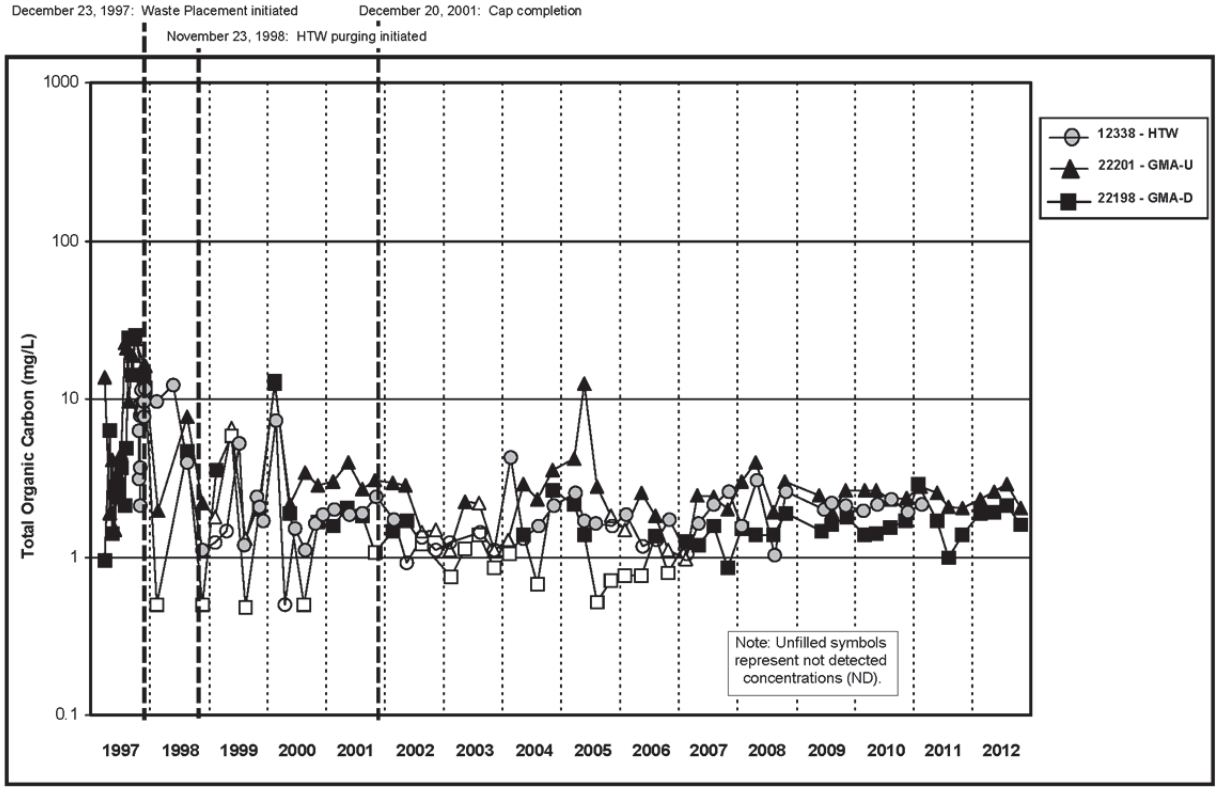


Figure A.5.1–13B. Cell 1 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

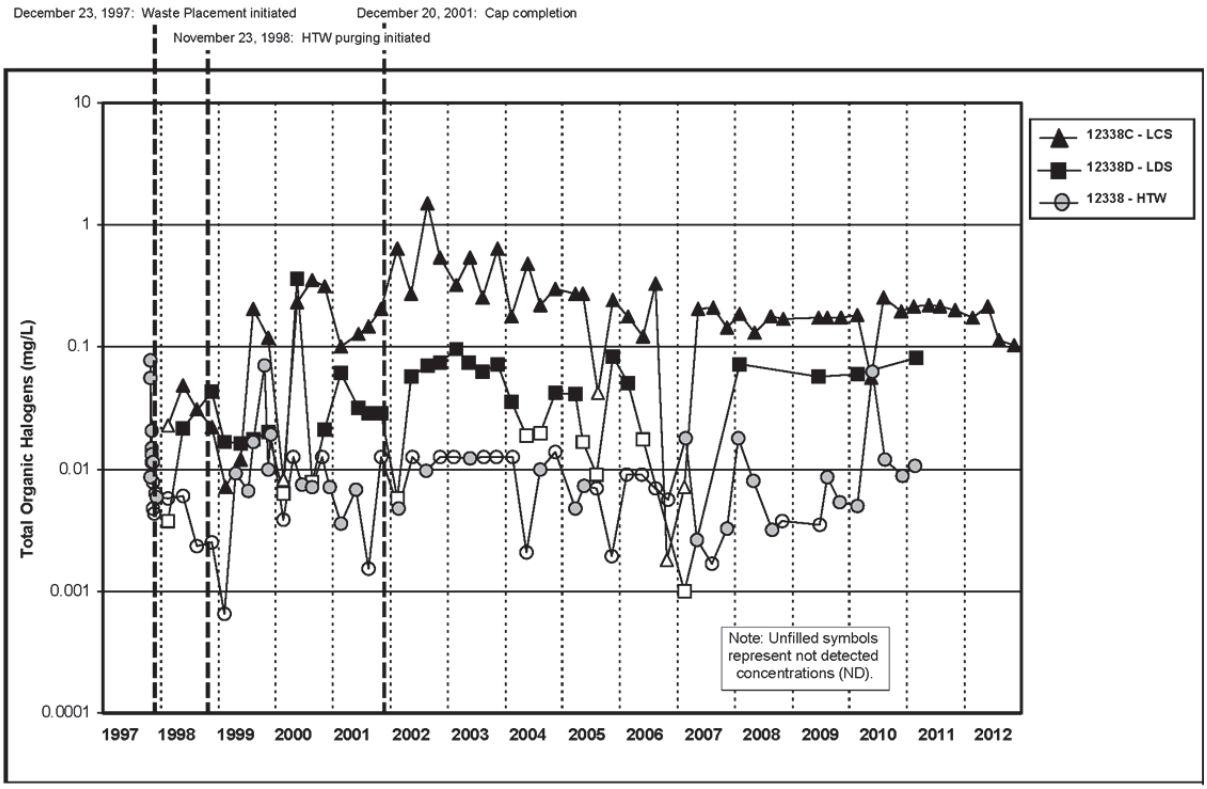


Figure A.5.1–14A. Cell 1 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, and HTW

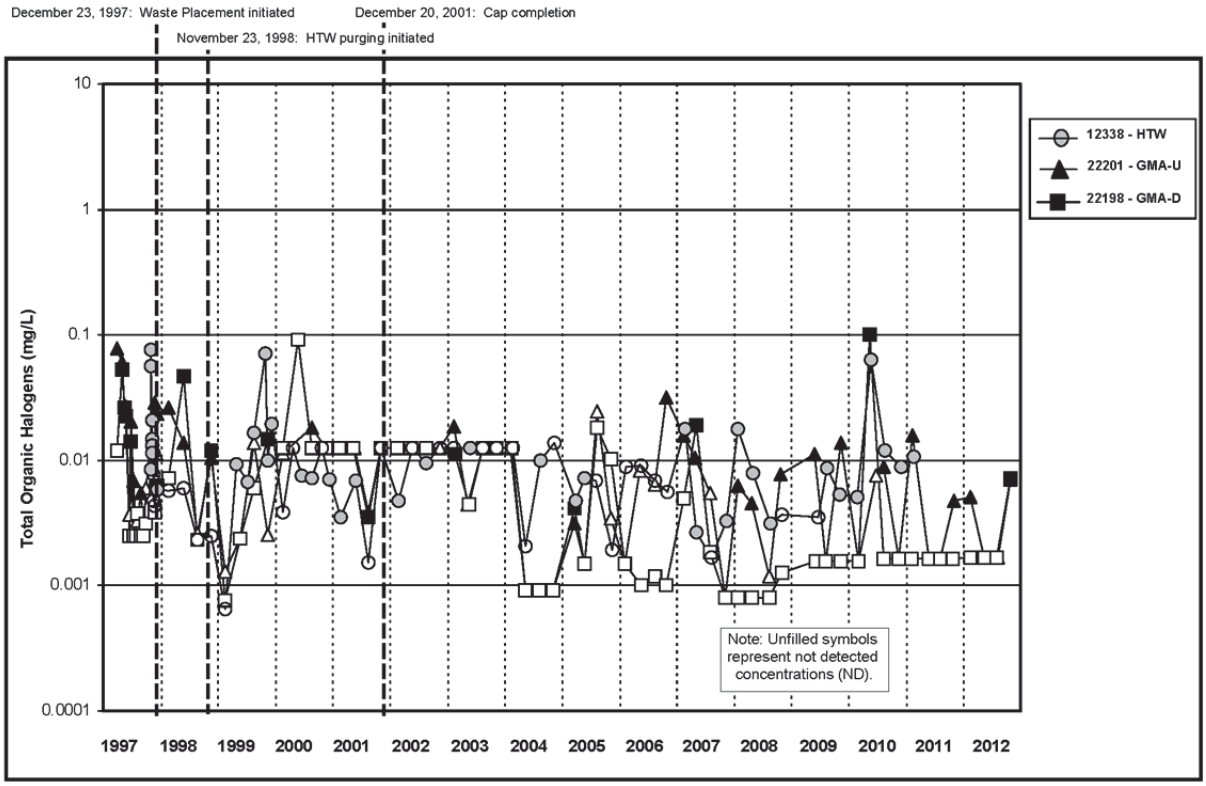


Figure A.5.1–14B. Cell 1 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

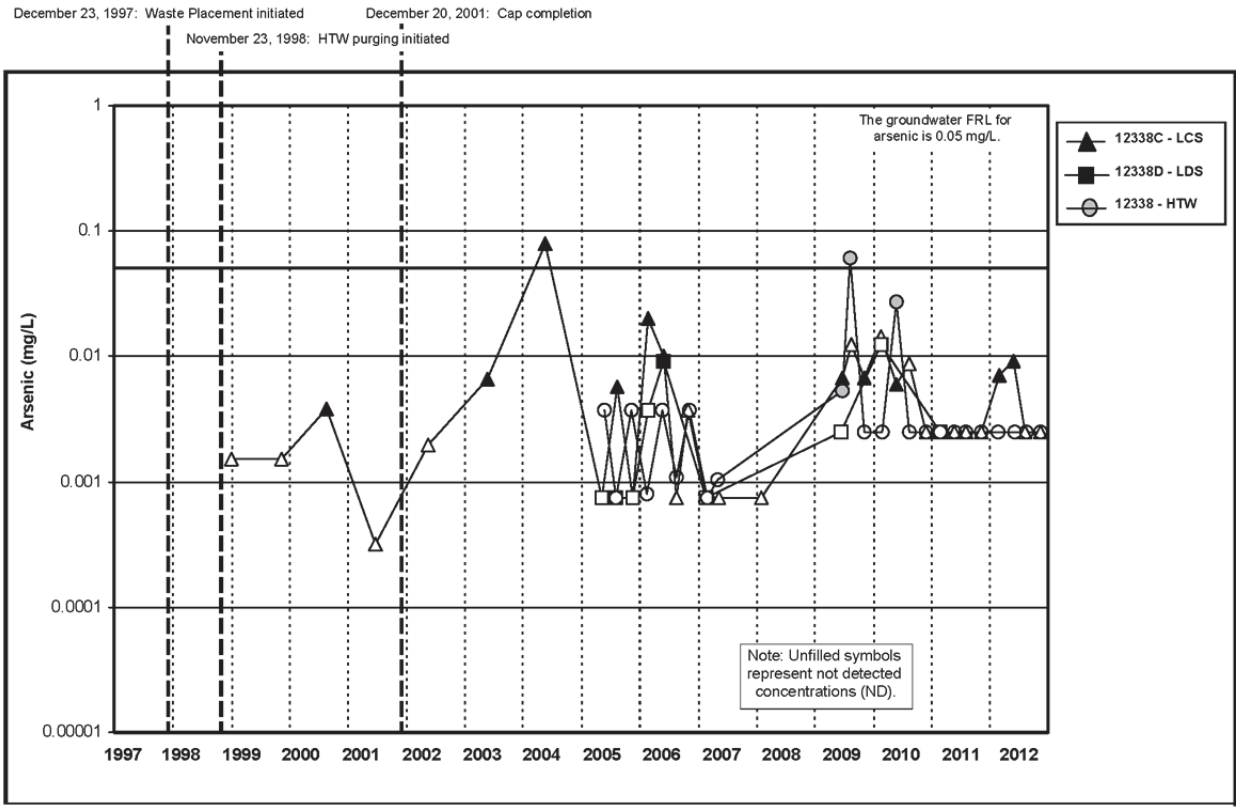


Figure A.5.1–15A. Cell 1 Arsenic Concentration vs. Time Plot for LCS, LDS, and HTW

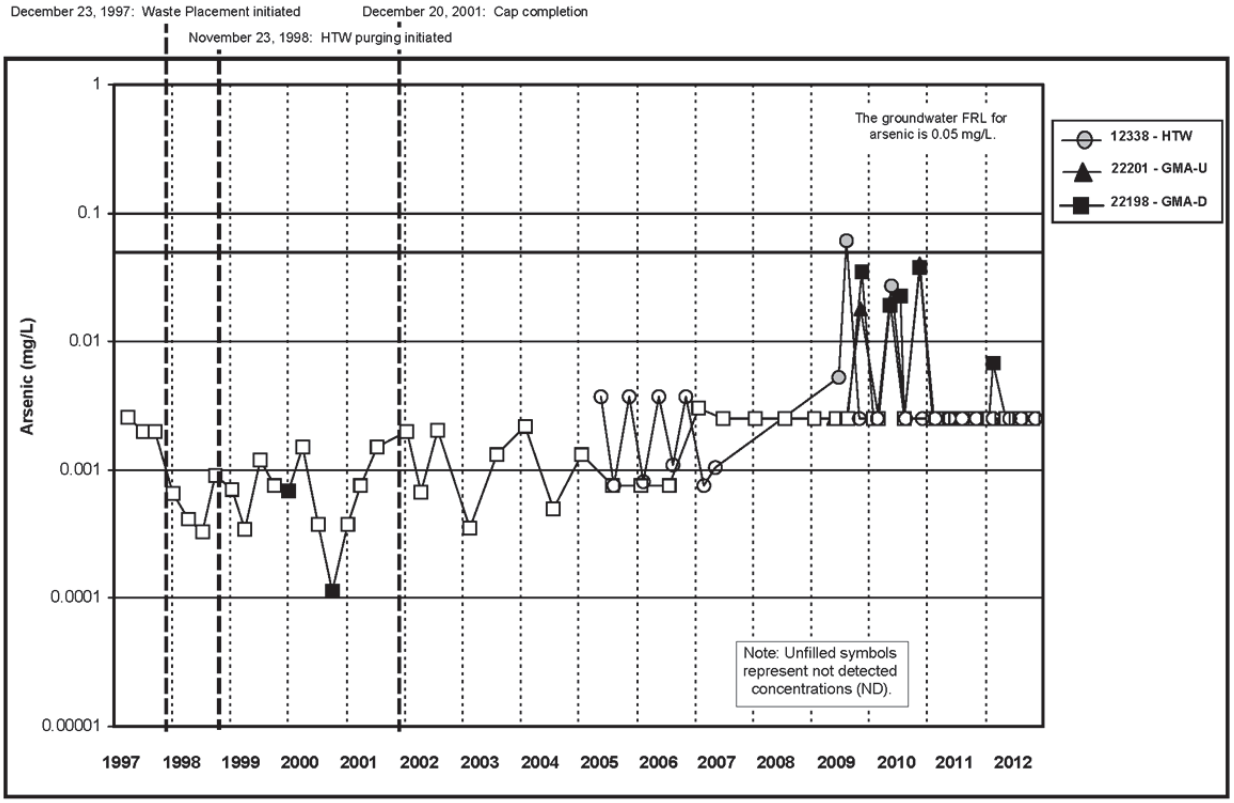


Figure A.5.1–15B. Cell 1 Arsenic Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

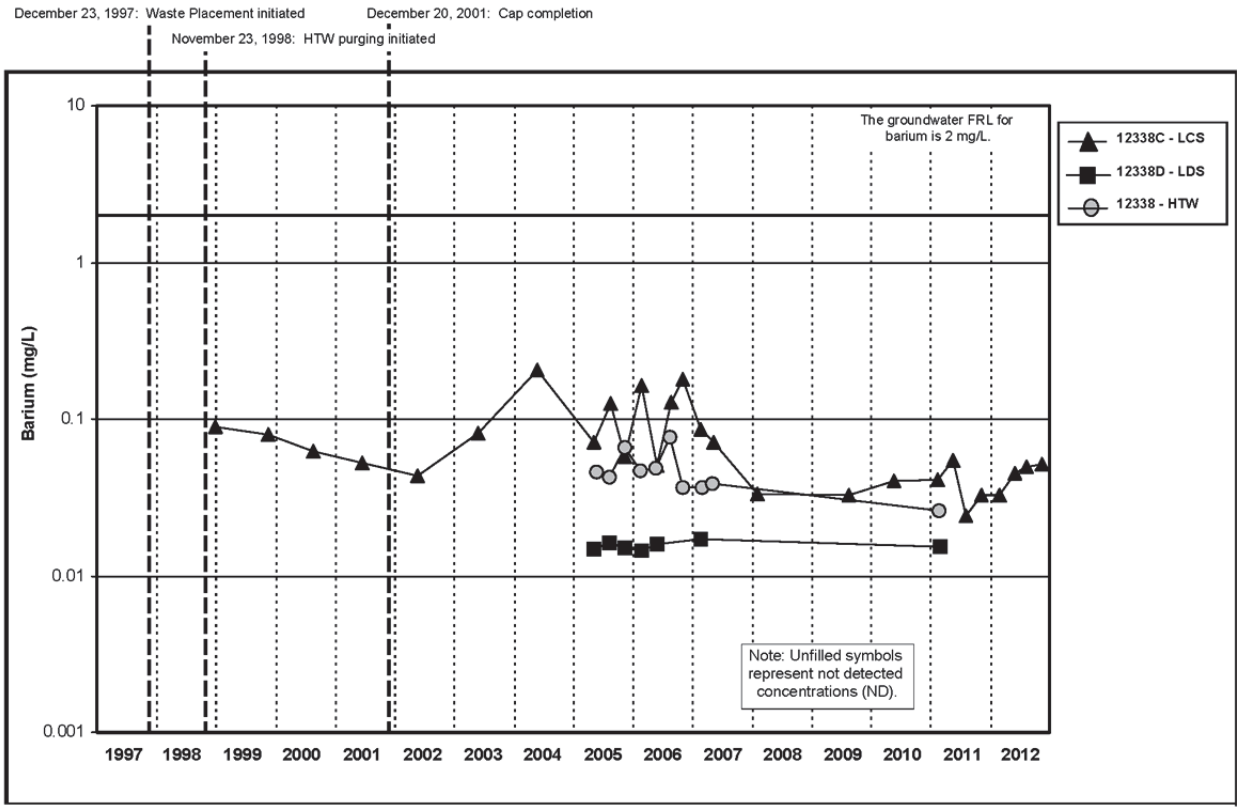


Figure A.5.1–16A. Cell 1 Barium Concentration vs. Time Plot for LCS, LDS, and HTW

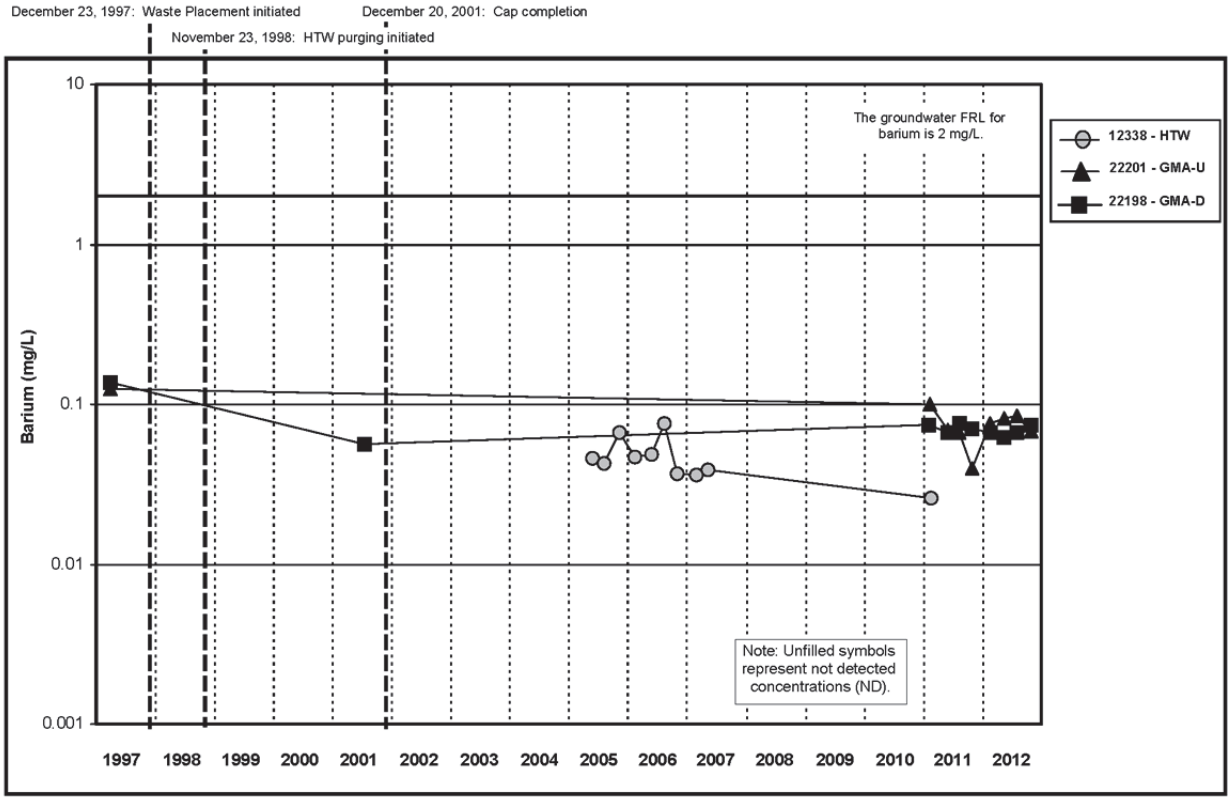


Figure A.5.1–16B. Cell 1 Barium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

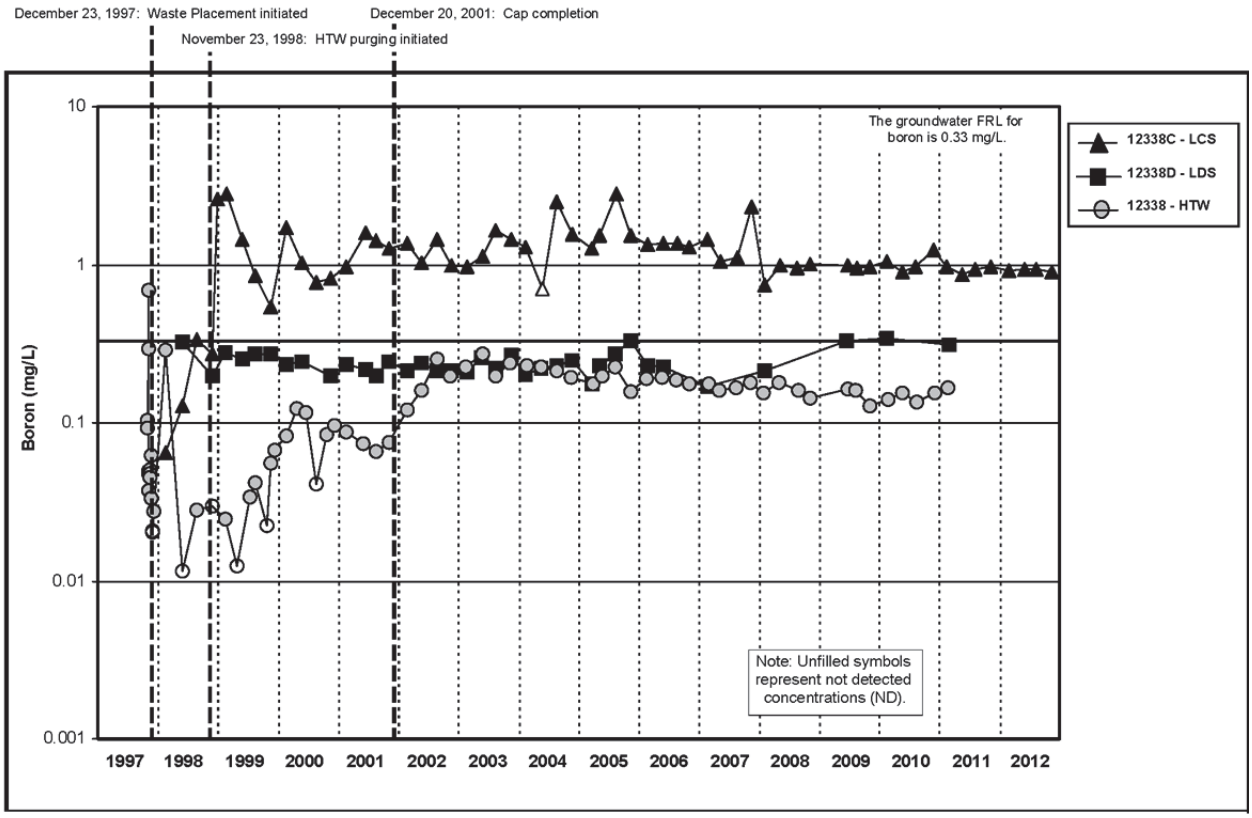


Figure A.5.1–17A. Cell 1 Boron Concentration vs. Time Plot for LCS, LDS, and HTW

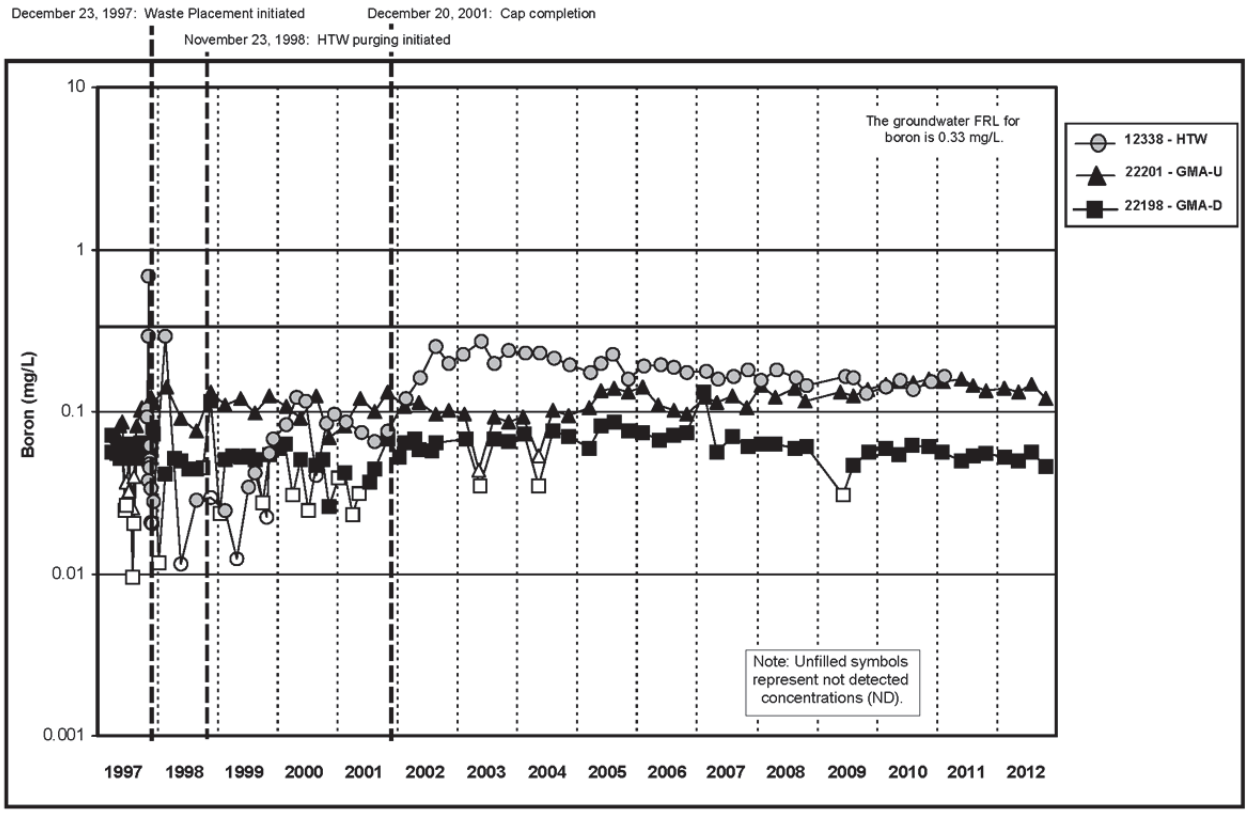


Figure A.5.1–17B. Cell 1 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

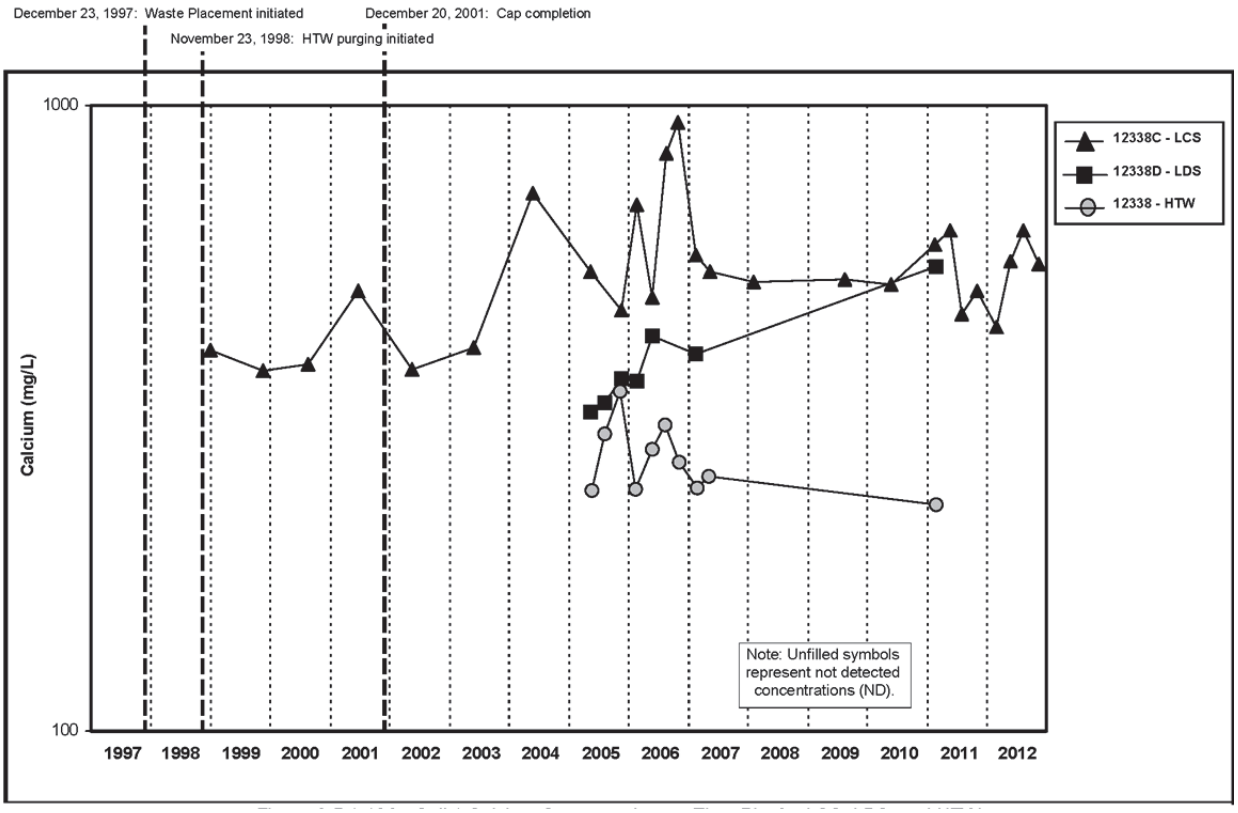


Figure A.5.1–18A. Cell 1 Calcium Concentration vs. Time Plot for LCS, LDS, and HTW

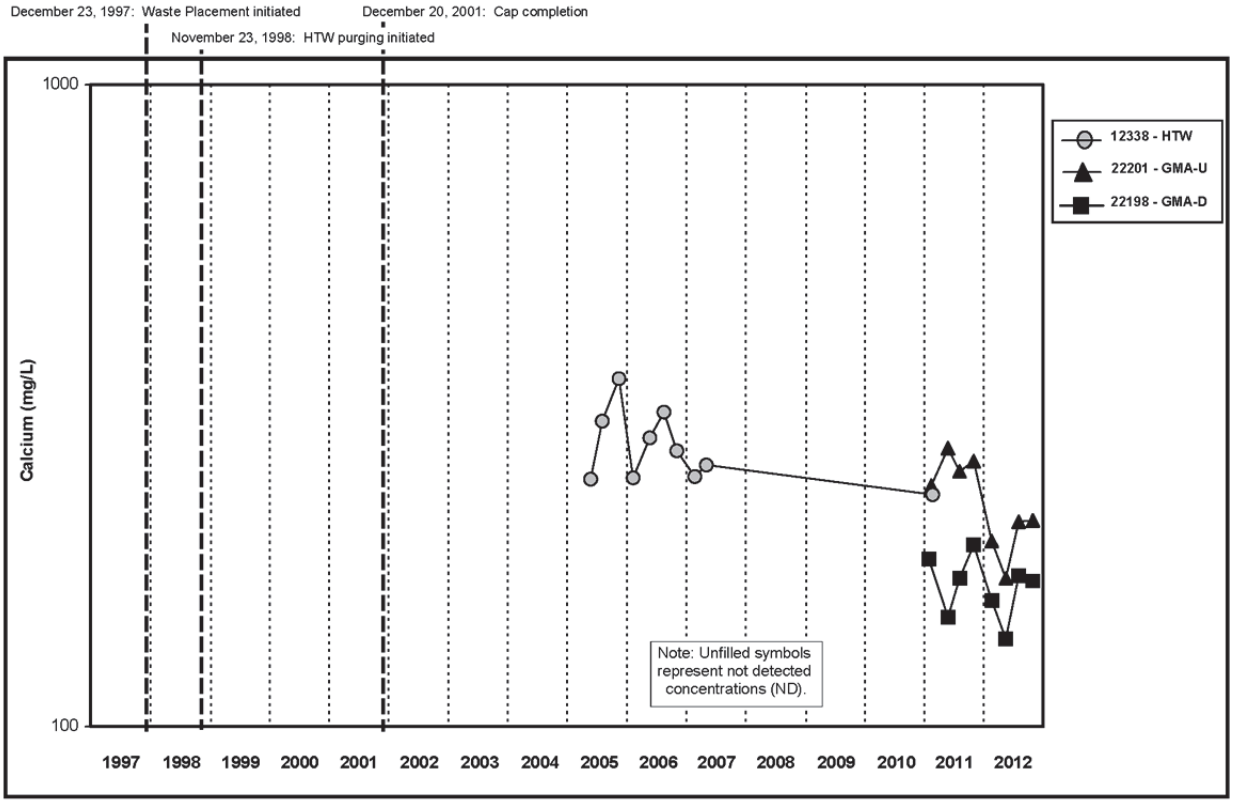


Figure A.5.1–18B. Cell 1 Calcium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

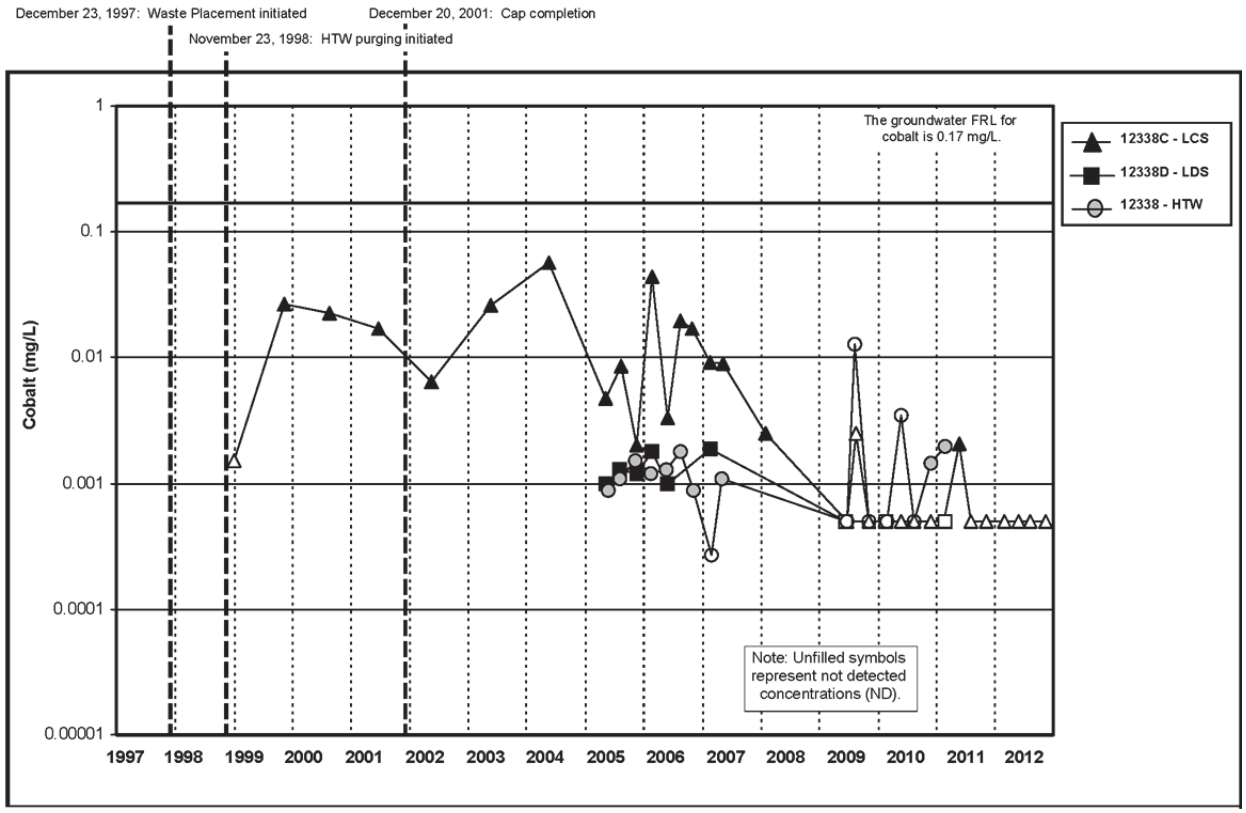


Figure A.5.1–19A. Cell 1 Cobalt Concentration vs. Time Plot for LCS, LDS, and HTW

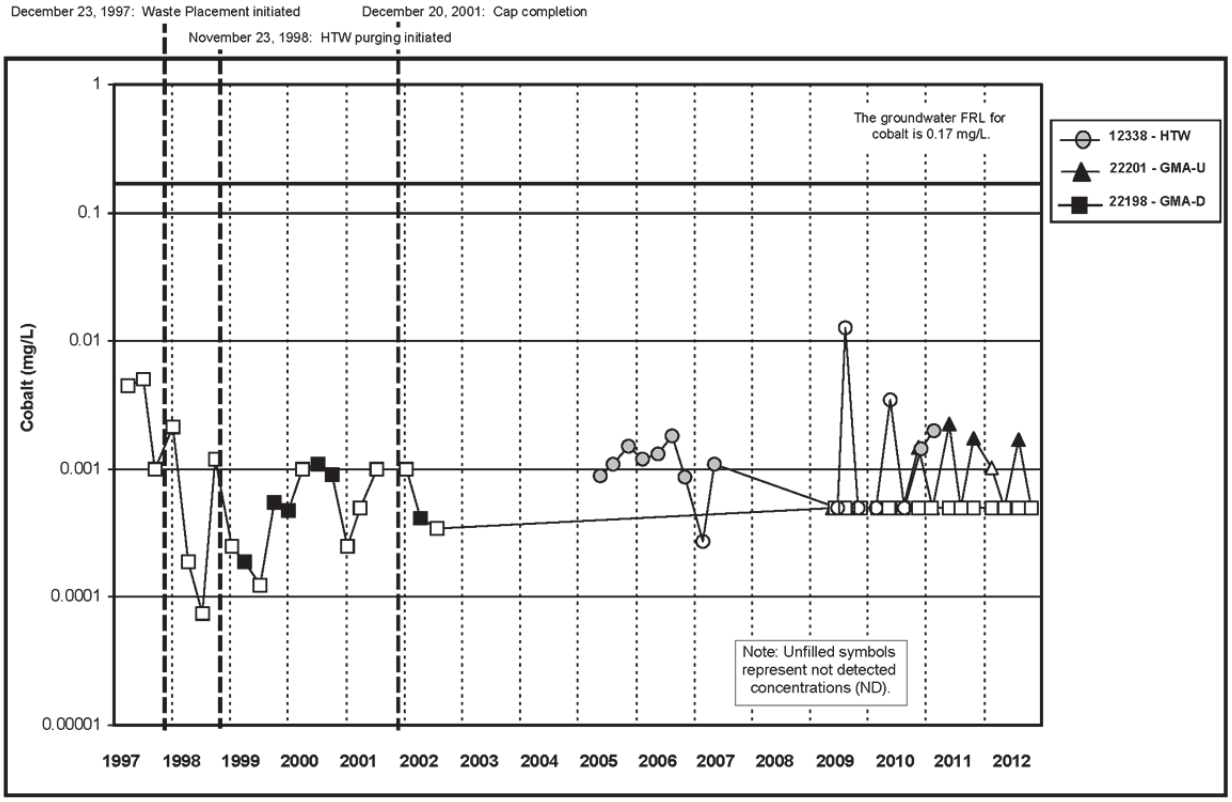


Figure A.5.1–19B. Cell 1 Cobalt Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

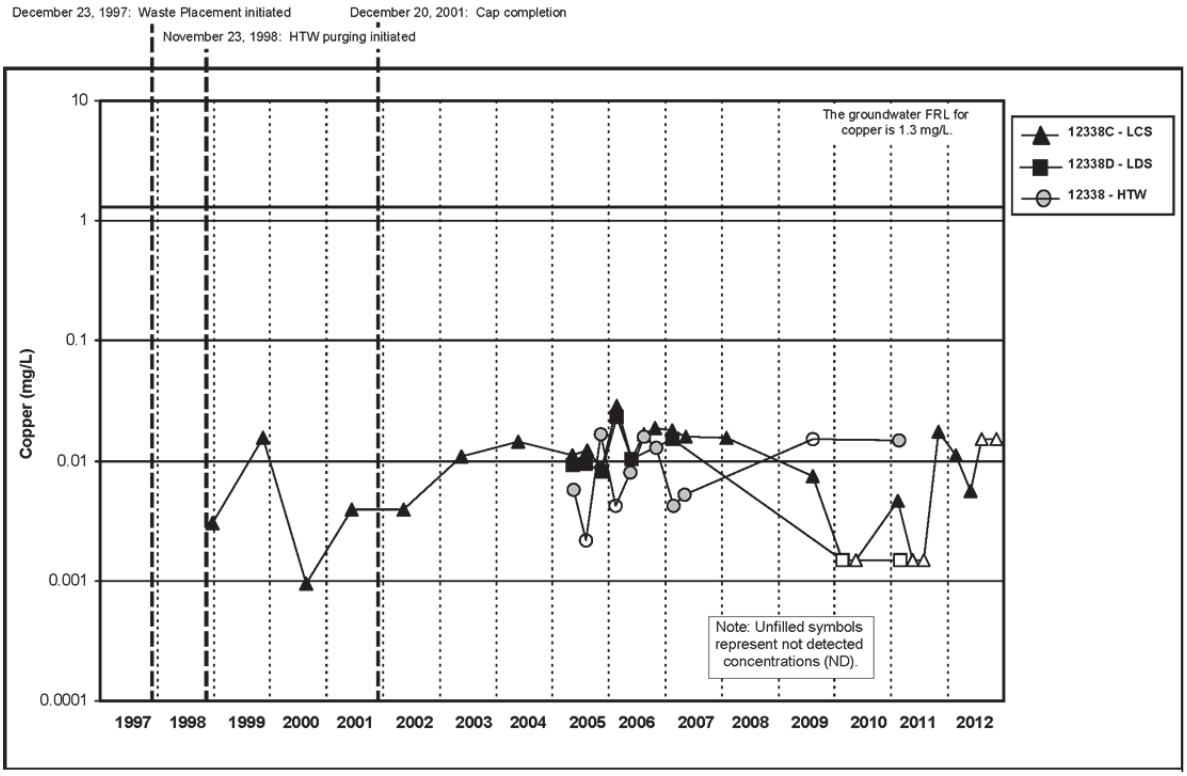


Figure A.5.1–20A. Cell 1 Copper Concentration vs. Time Plot for LCS, LDS, and HTW

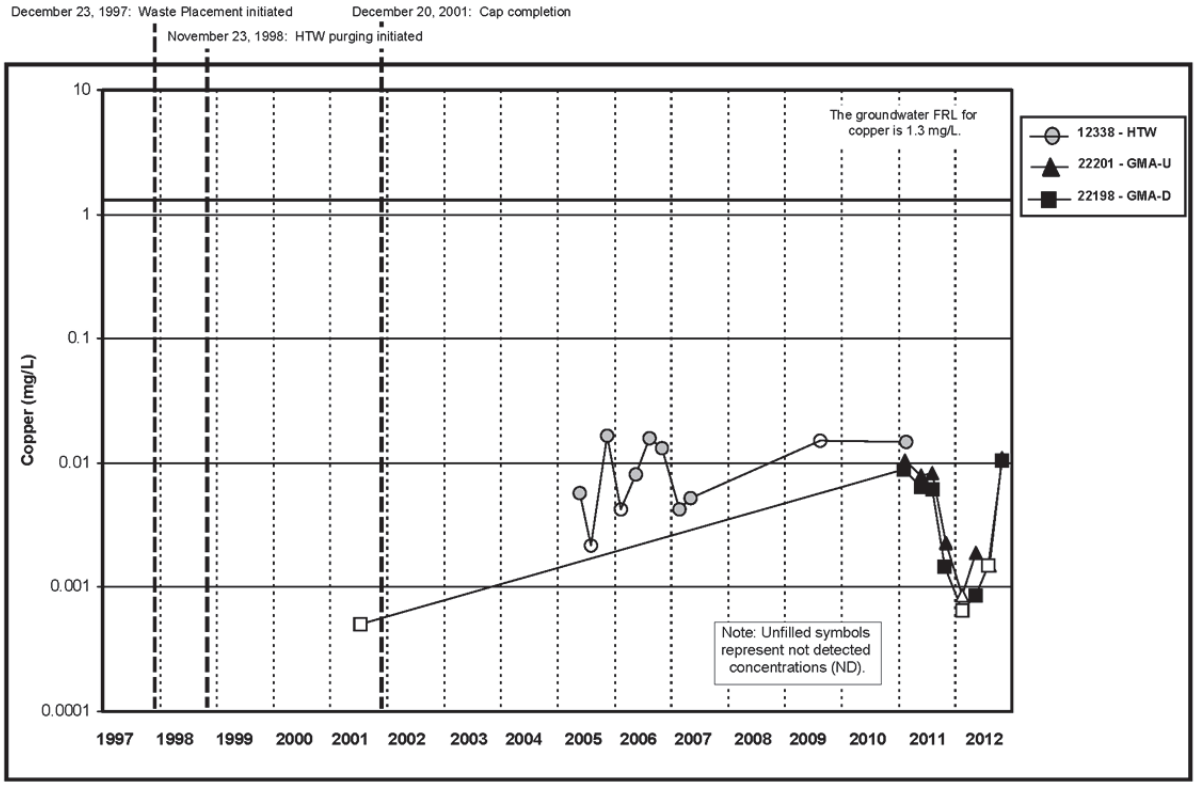


Figure A.5.1–20B. Cell 1 Copper Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

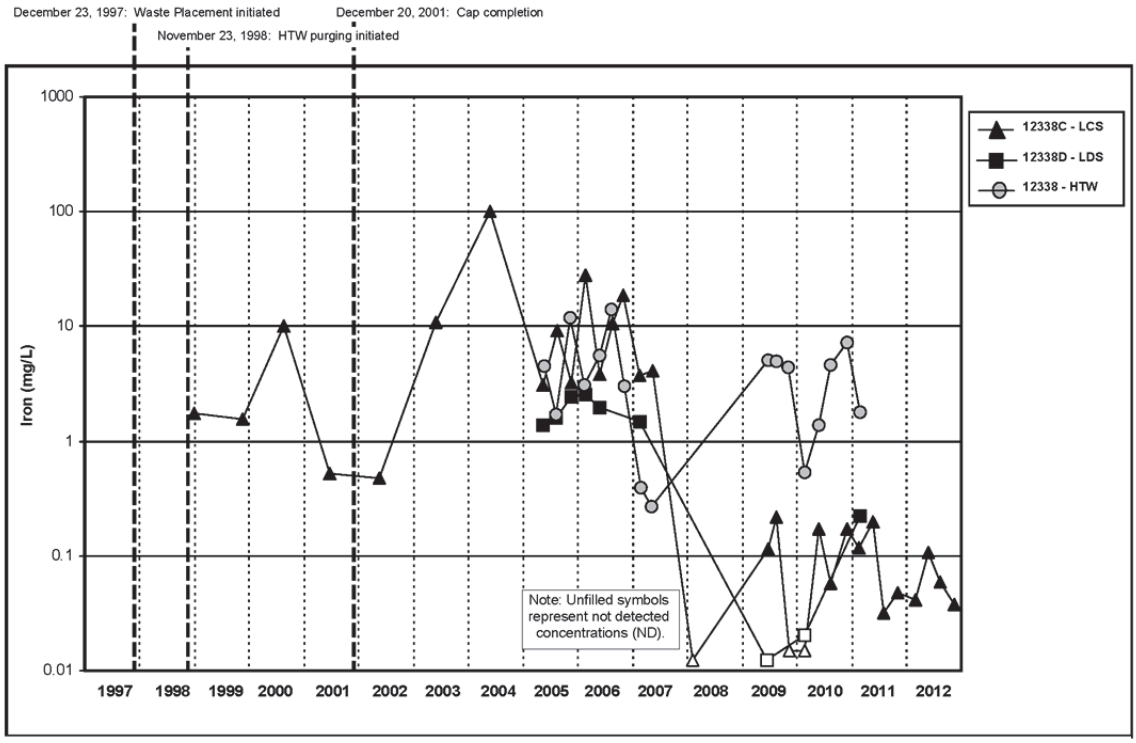


Figure A.5.1–21A. Cell 1 Iron Concentration vs. Time Plot for LCS, LDS, and HTW

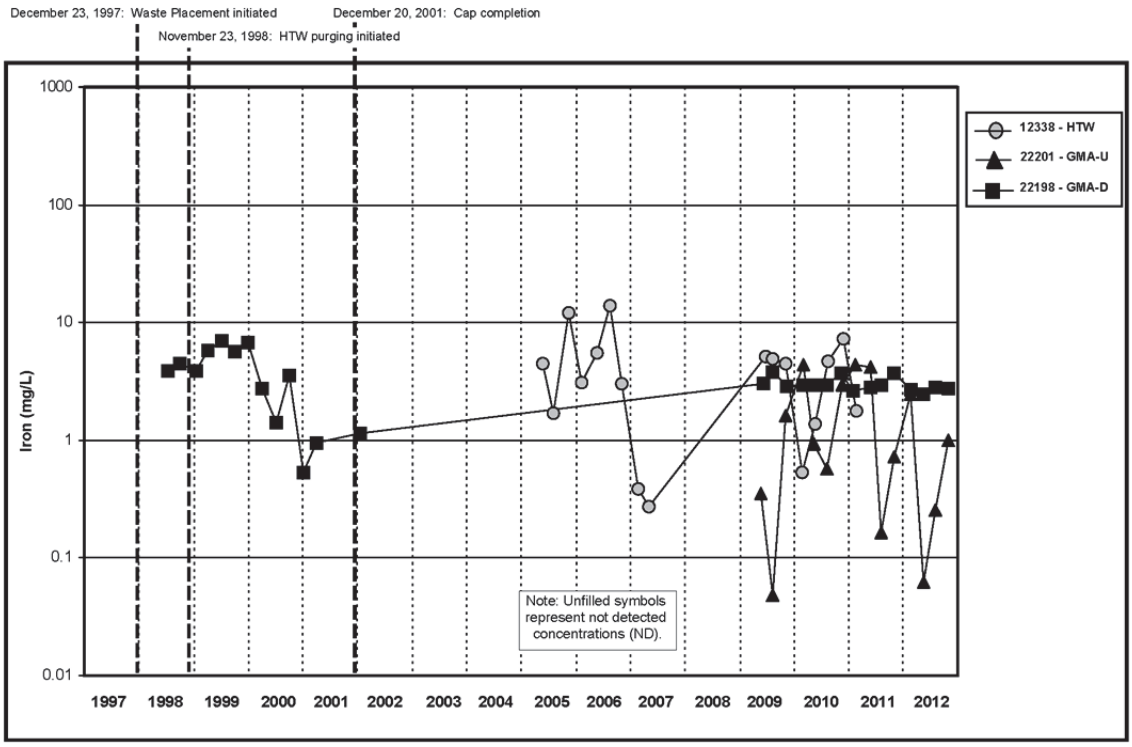


Figure A.5.1–21B. Cell 1 Iron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

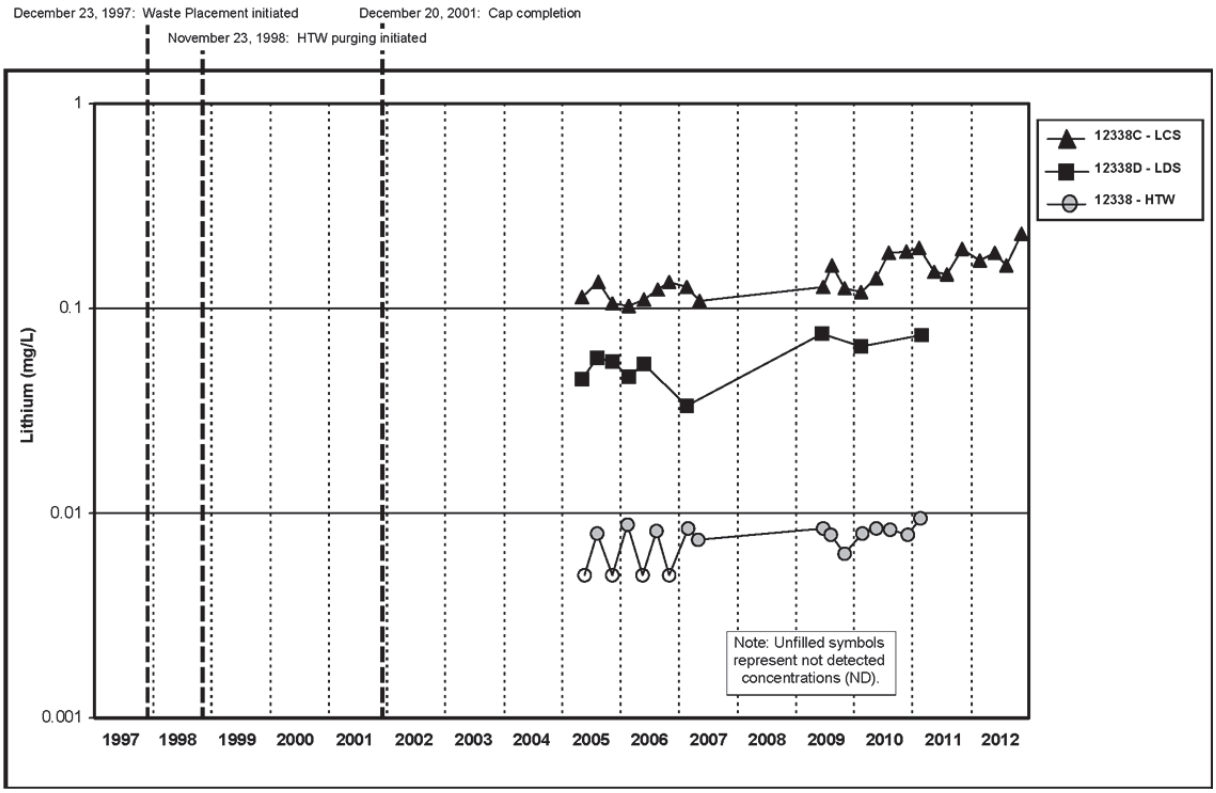


Figure A.5.1–22A. Cell 1 Lithium Concentration vs. Time Plot for LCS, LDS, and HTW

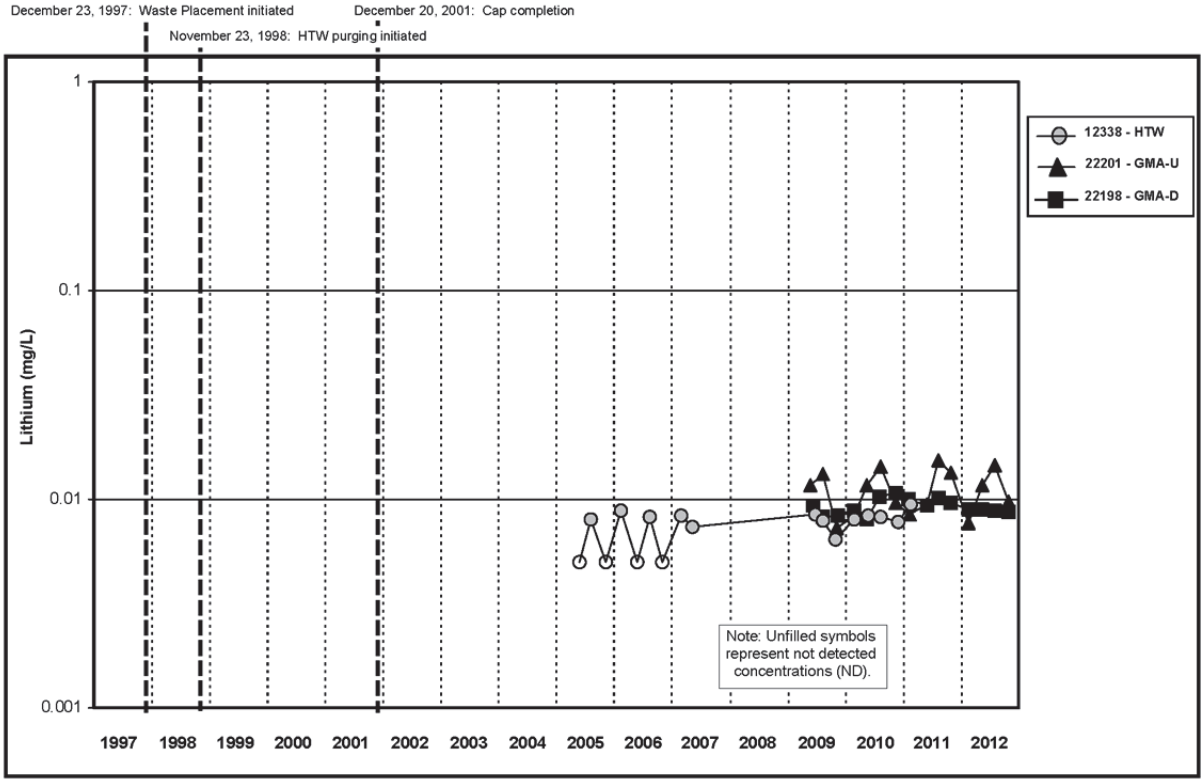


Figure A.5.1–22B. Cell 1 Lithium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

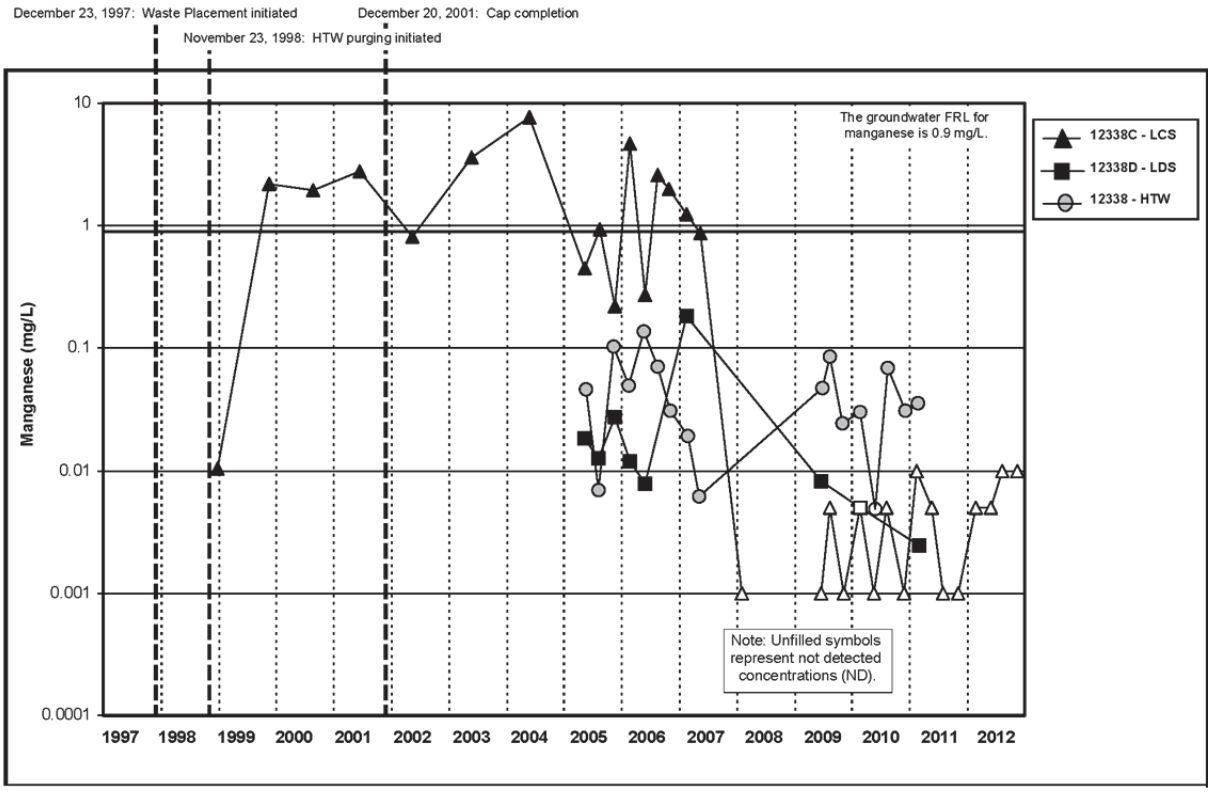


Figure A.5.1–23A. Cell 1 Manganese Concentration vs. Time Plot for LCS, LDS, and HTW

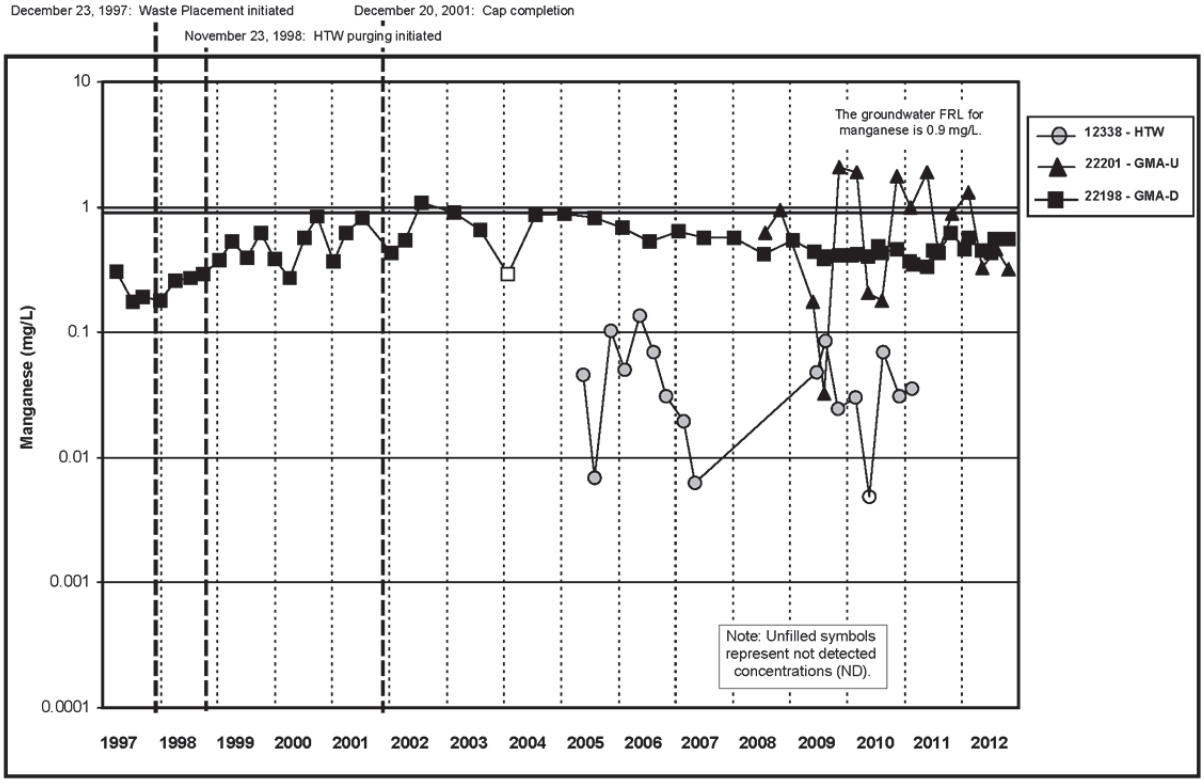


Figure A.5.1–23B. Cell 1 Manganese Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

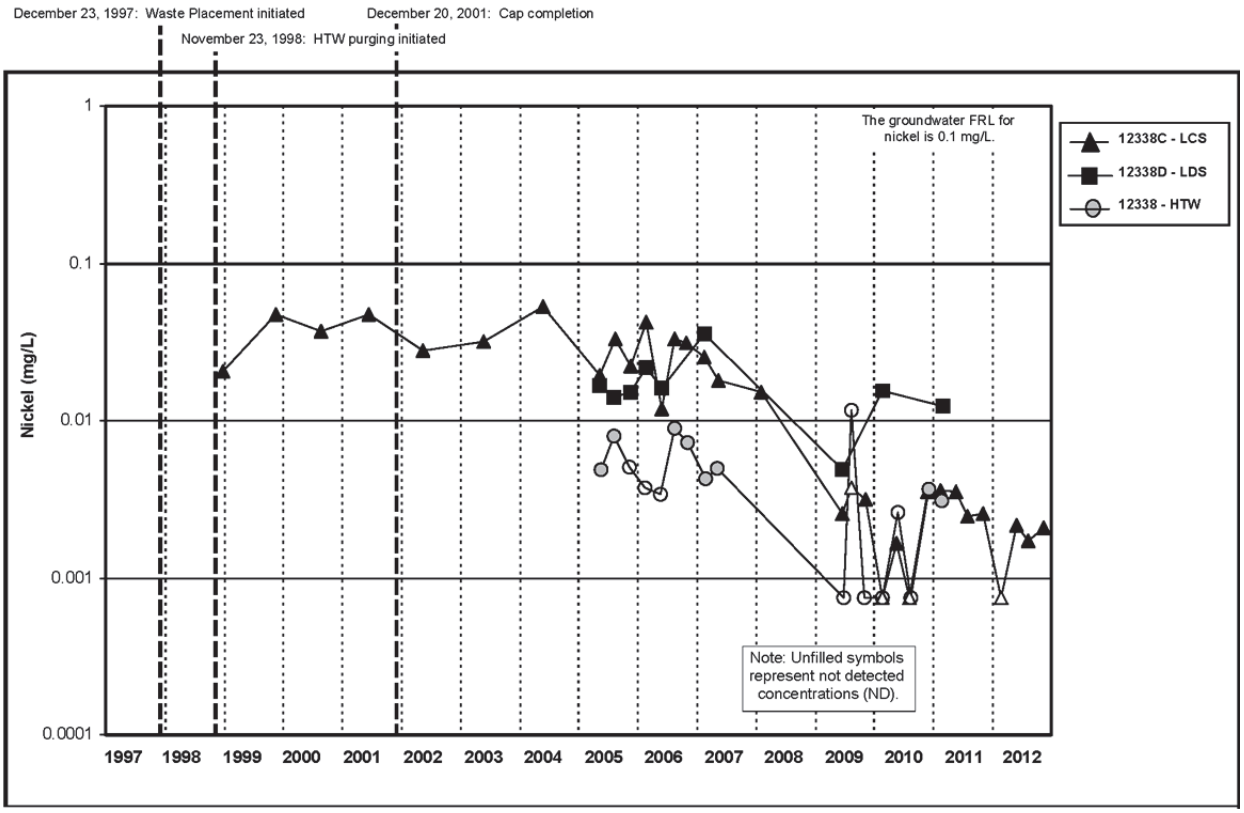


Figure A.5.1–24A. Cell 1 Nickel Concentration vs. Time Plot for LCS, LDS, and HTW

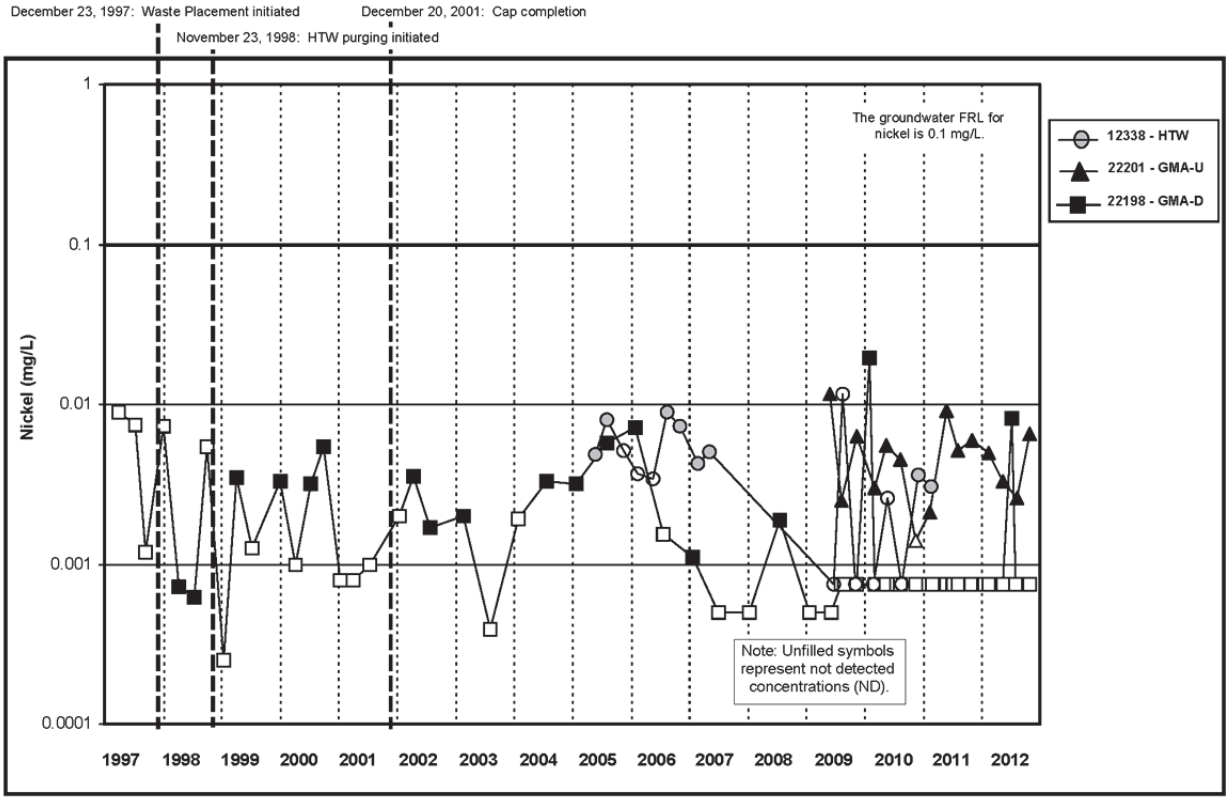
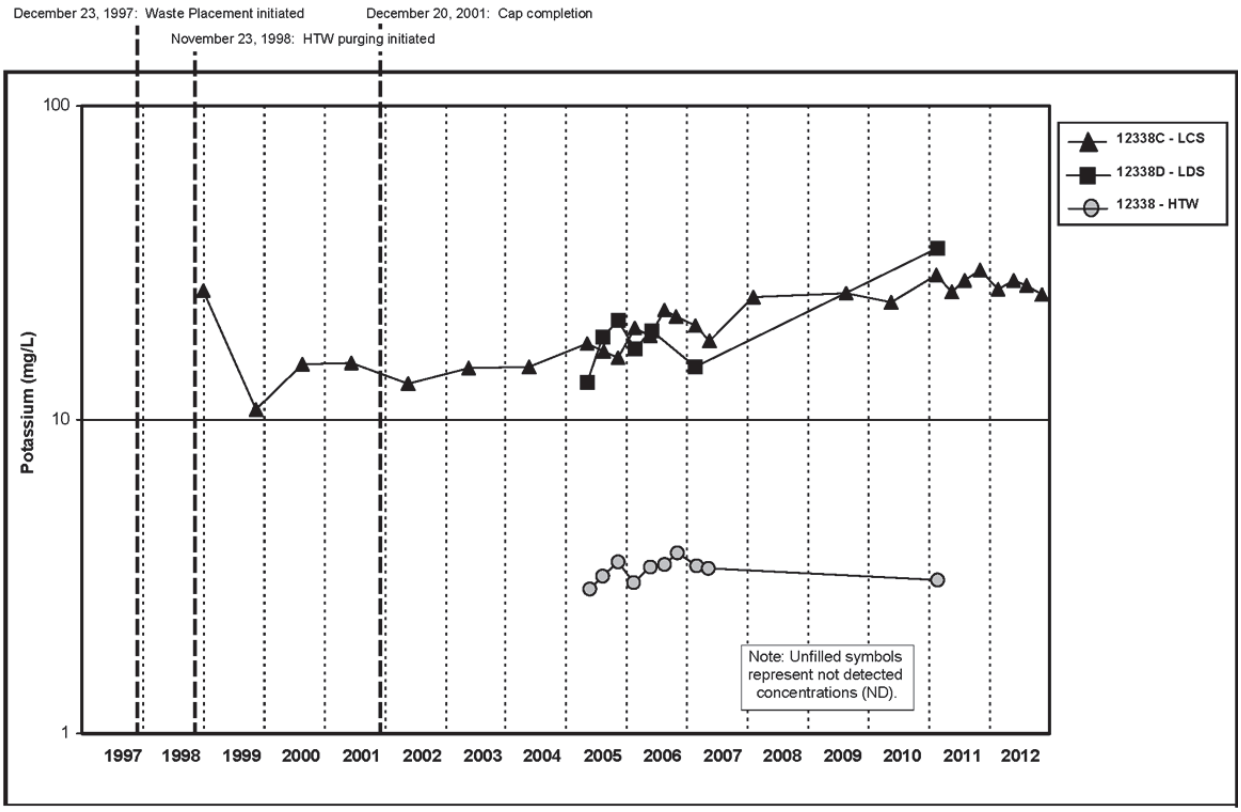


Figure A.5.1–24B. Cell 1 Nickel Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well



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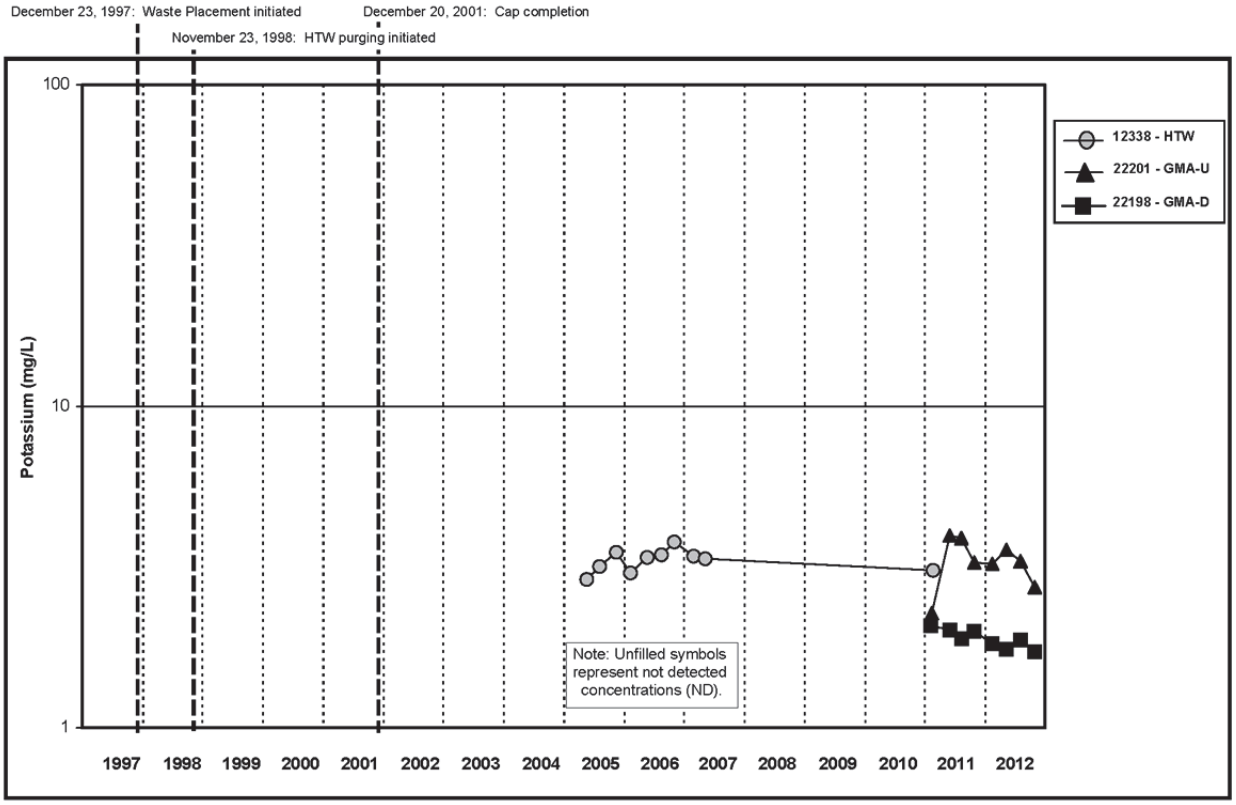


Figure A.5.1–25B. Cell 1 Potassium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

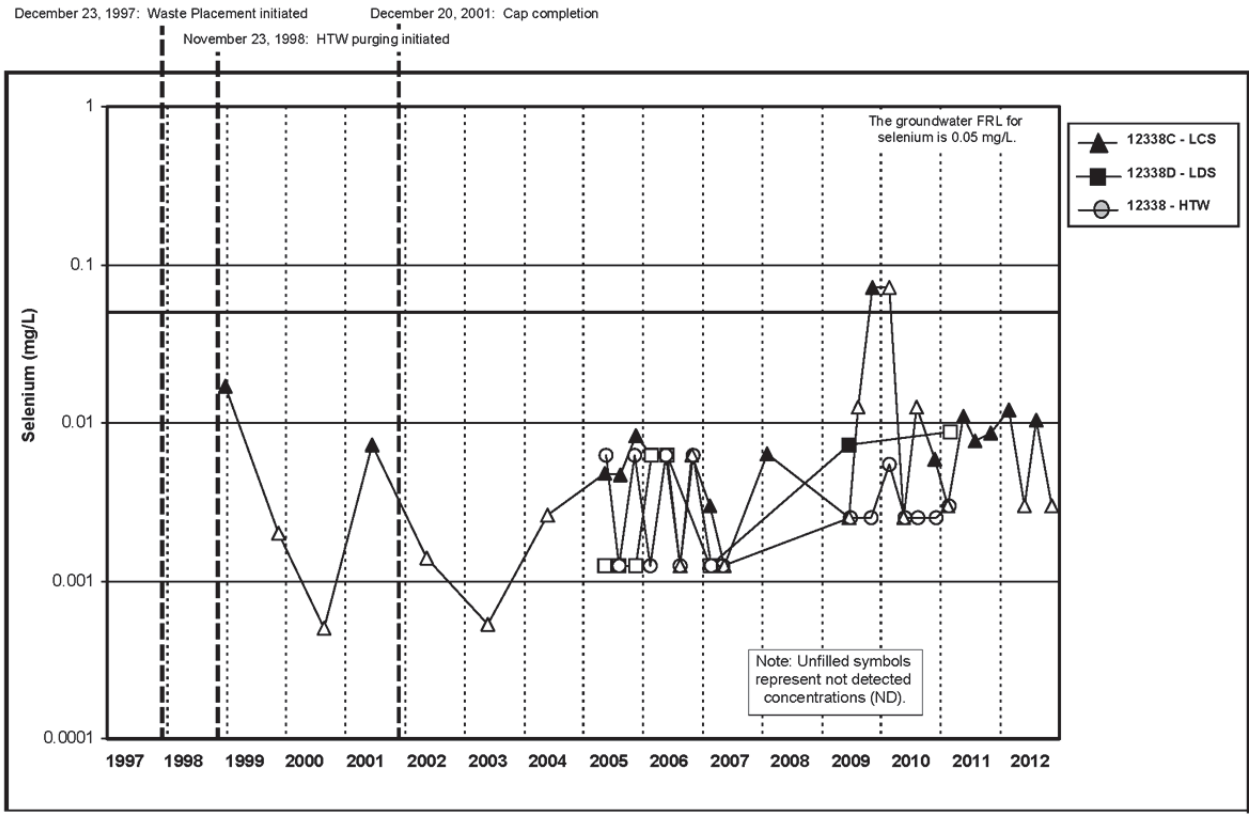


Figure A.5.1–26A. Cell 1 Selenium Concentration vs. Time Plot for LCS, LDS, and HTW

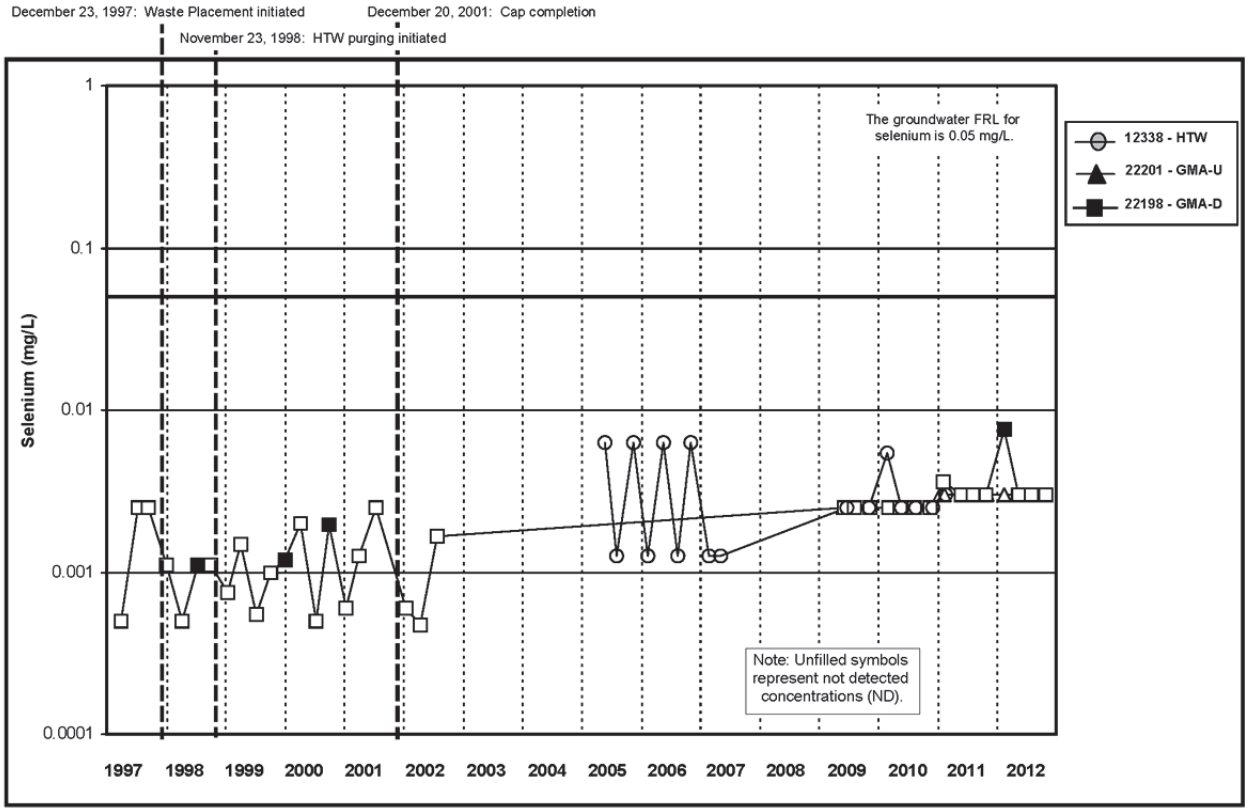


Figure A.5.1–26B. Cell 1 Selenium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

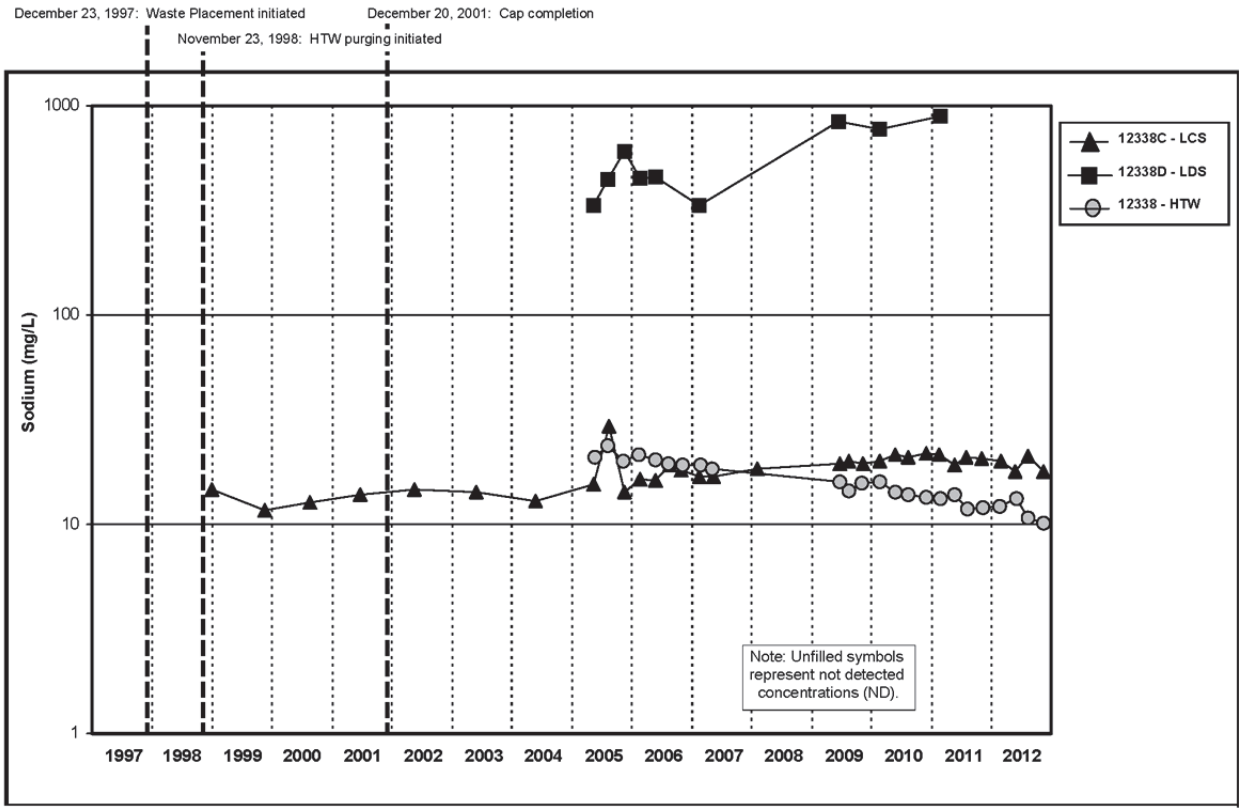
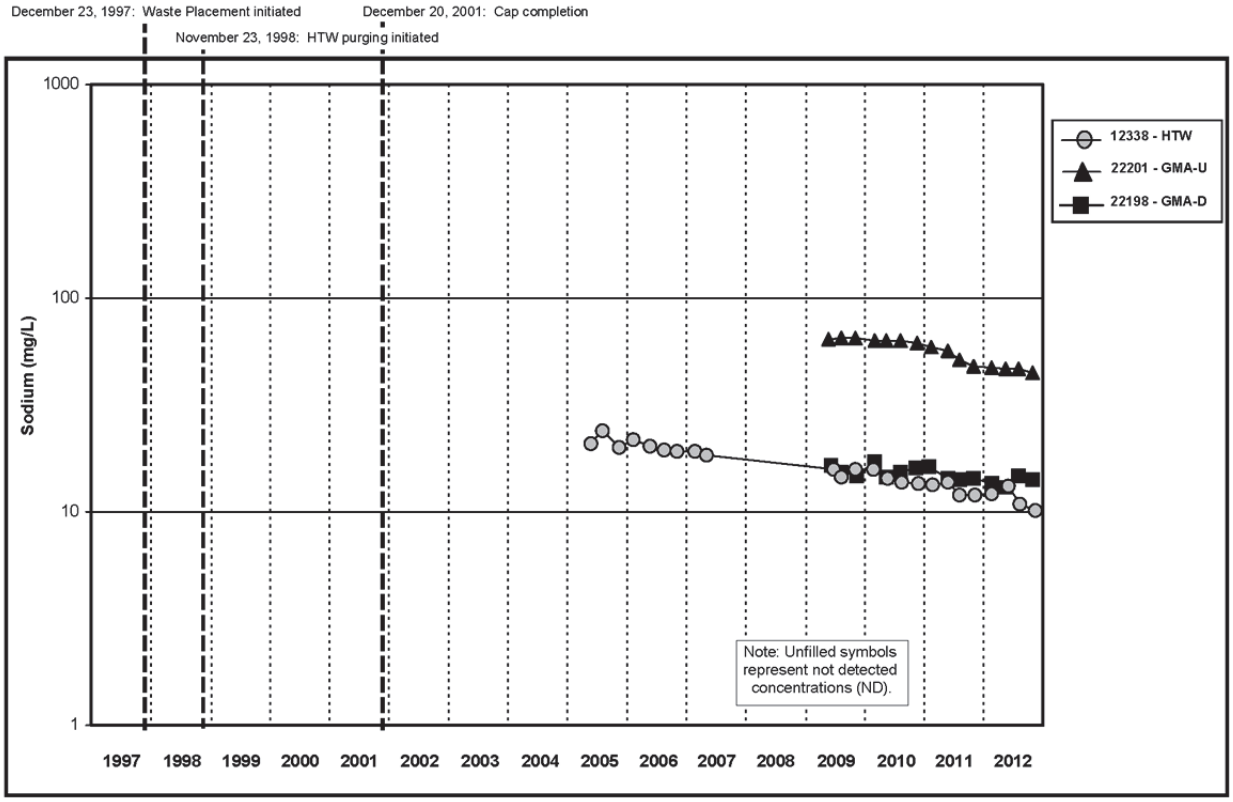


Figure A.5.1–27A. Cell 1 Sodium Concentration vs. Time Plot for LCS, LDS, and HTW



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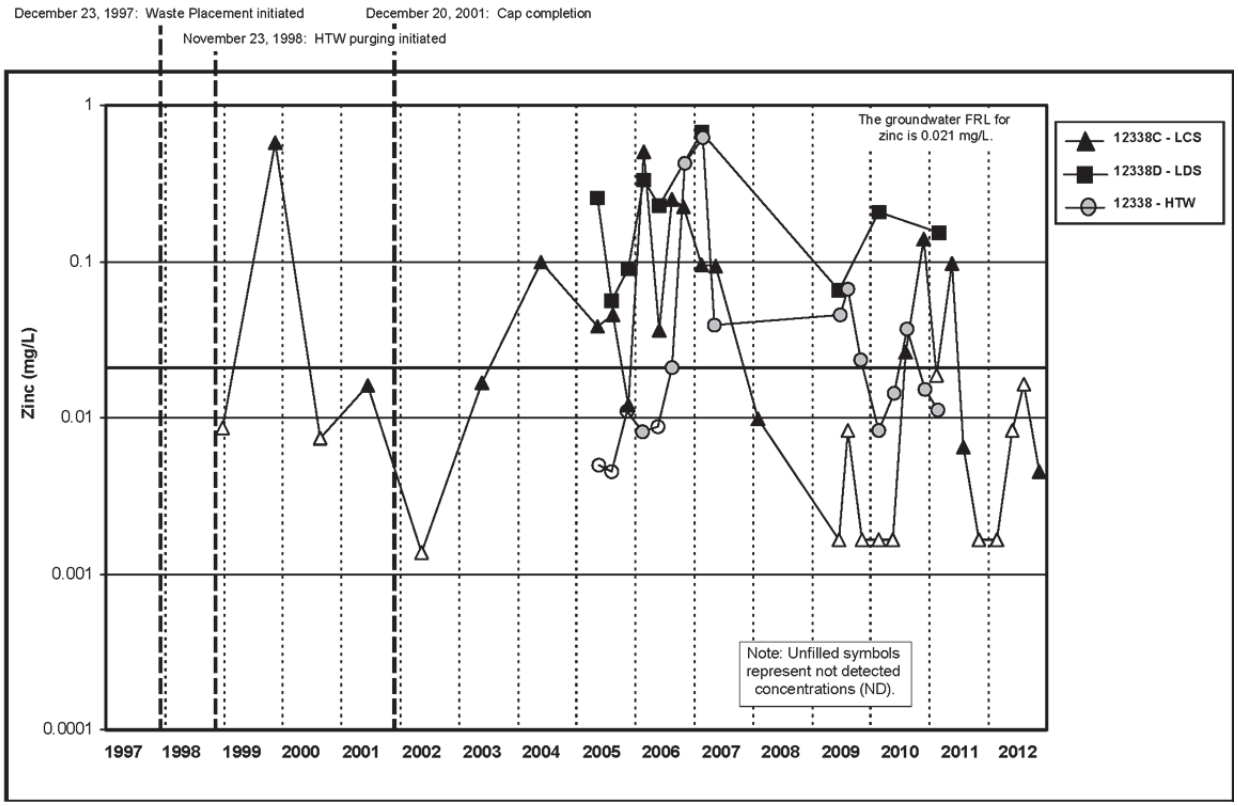

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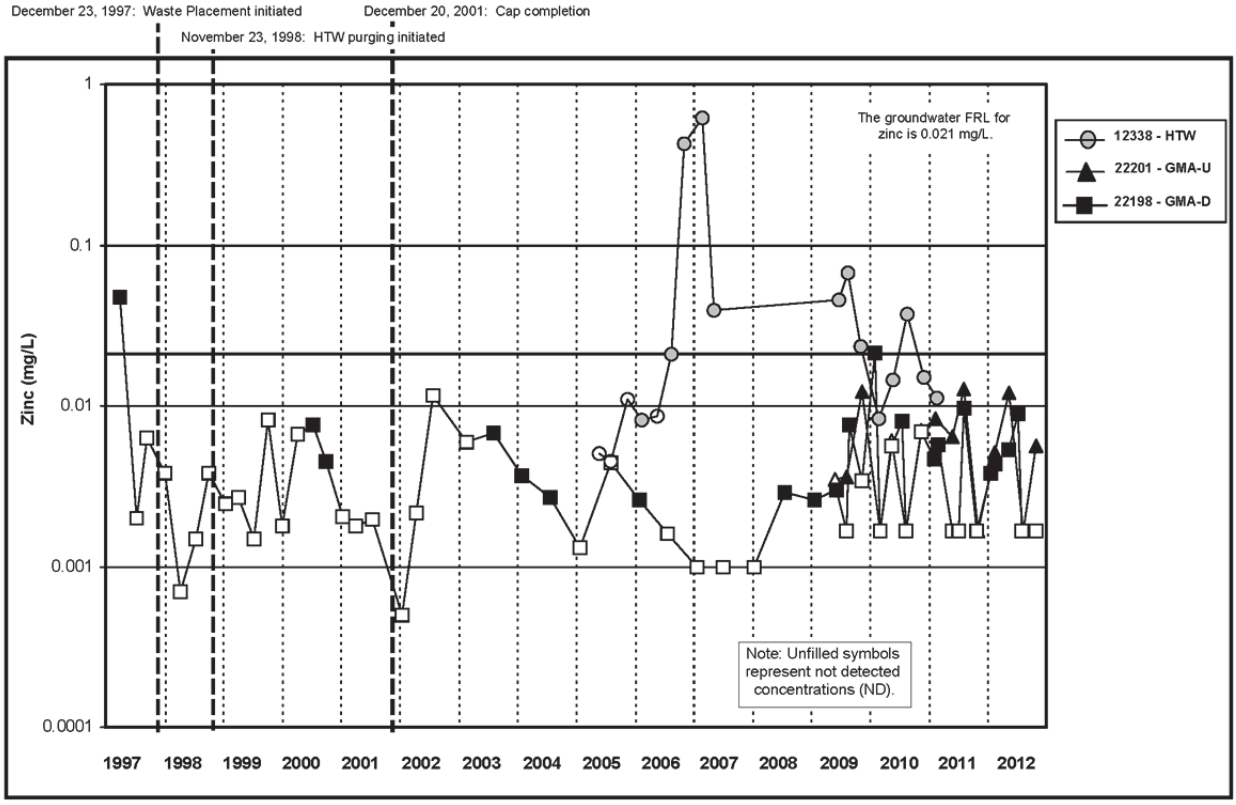


Figure A.5.1–28B. Cell 1 Zinc Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

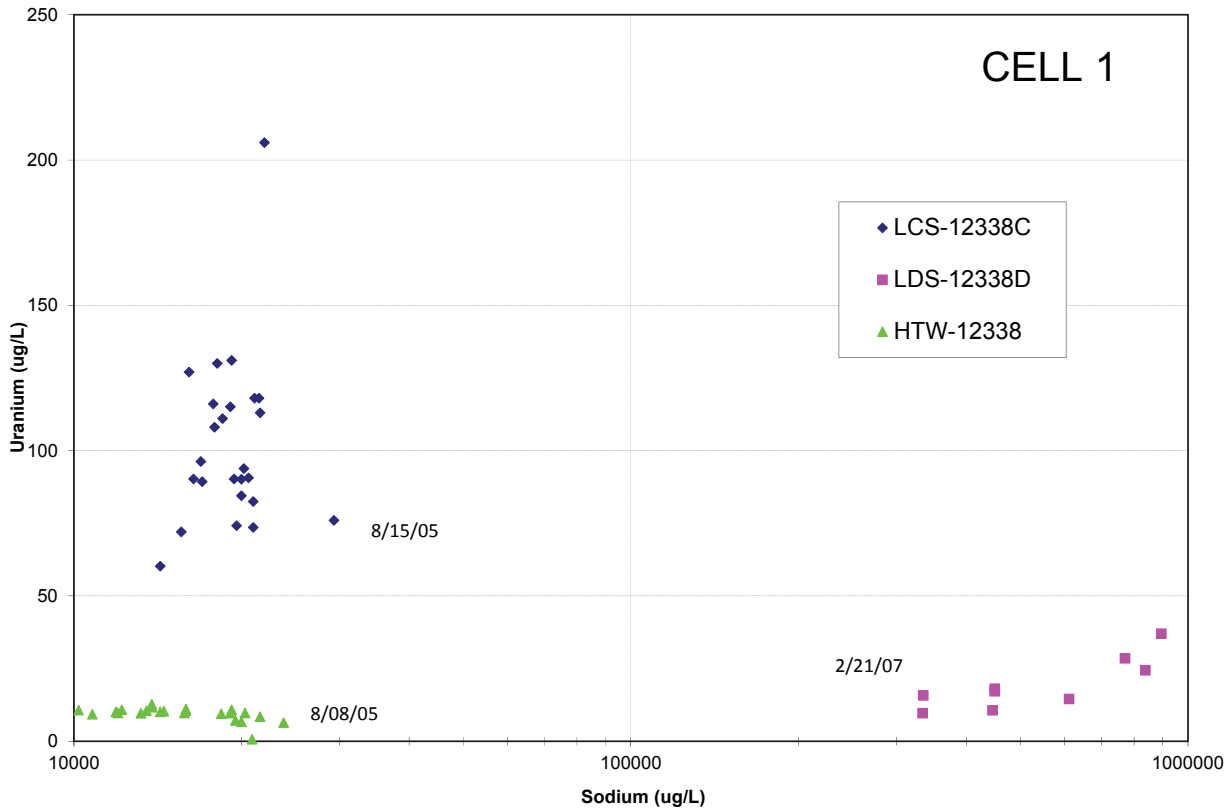


Figure A.5.1–29. Cell 1 Bivariate Plot for Uranium and Sodium

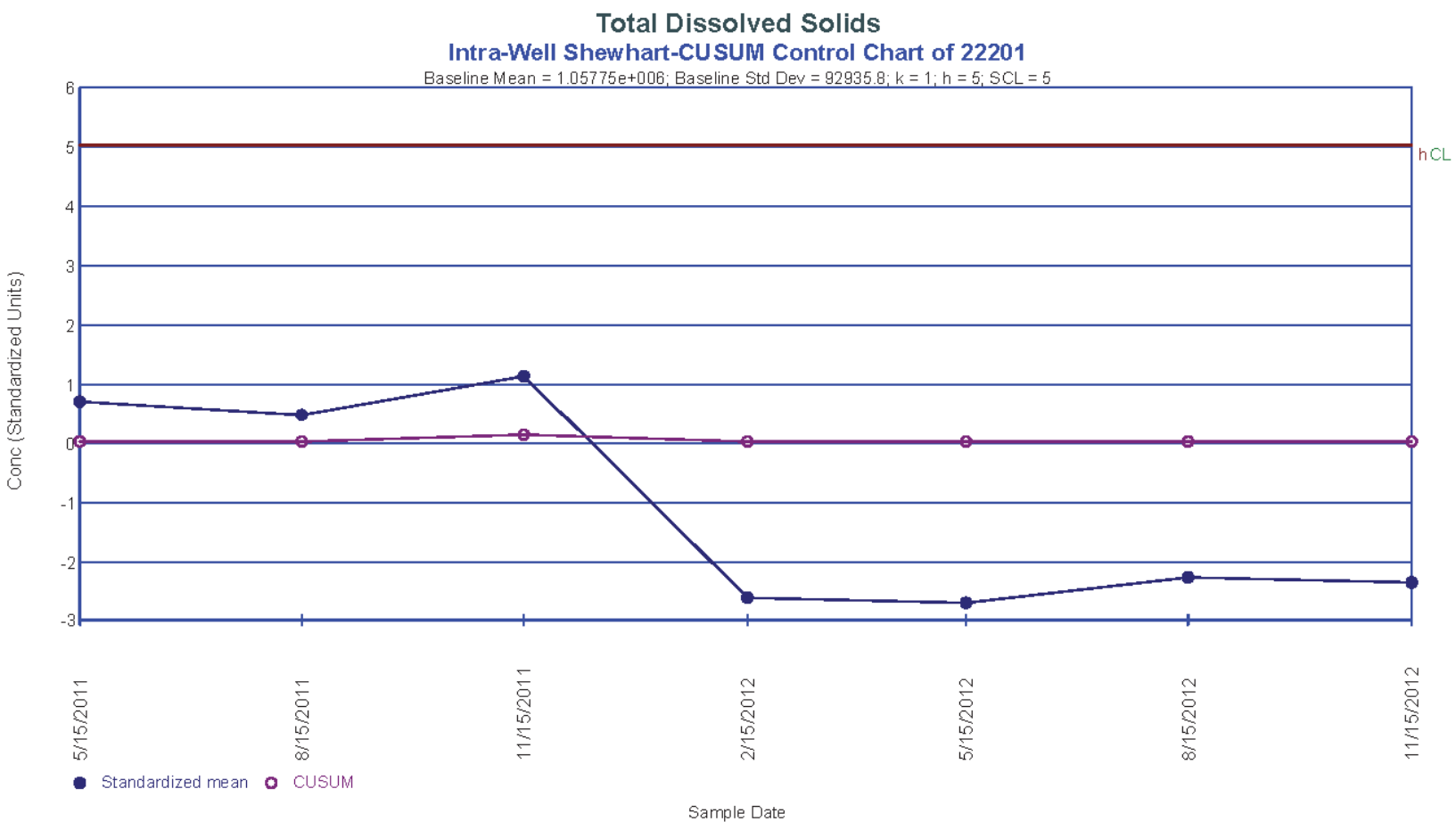


Figure A.5.1–30. Intra-Well Shewhart-CUSUM Control Chart (Total Dissolved Solids 22201)

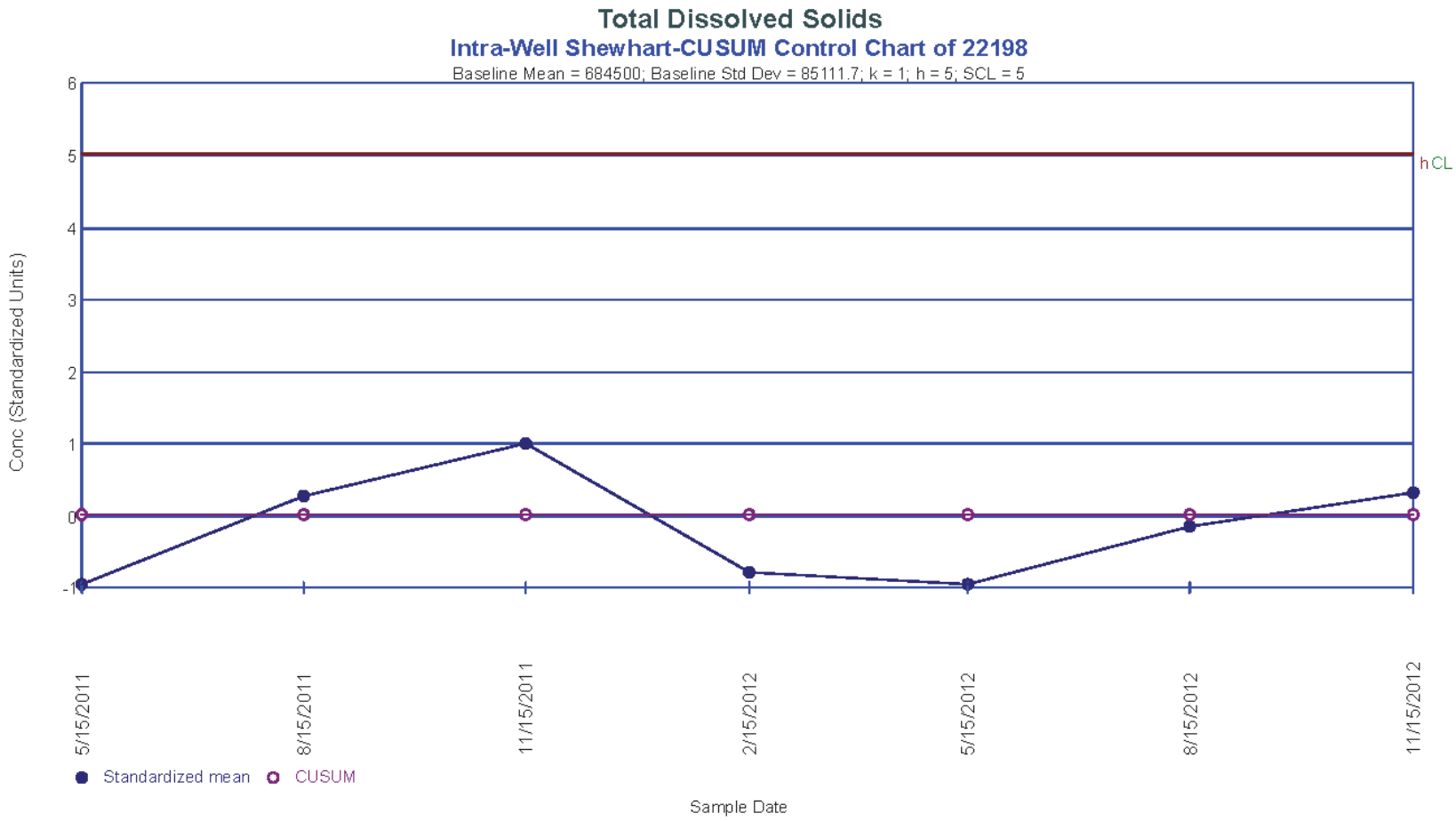


Figure A.5.1–31. Intra-Well Shewhart-CUSUM Control Chart (Total Dissolved Solids 22198)

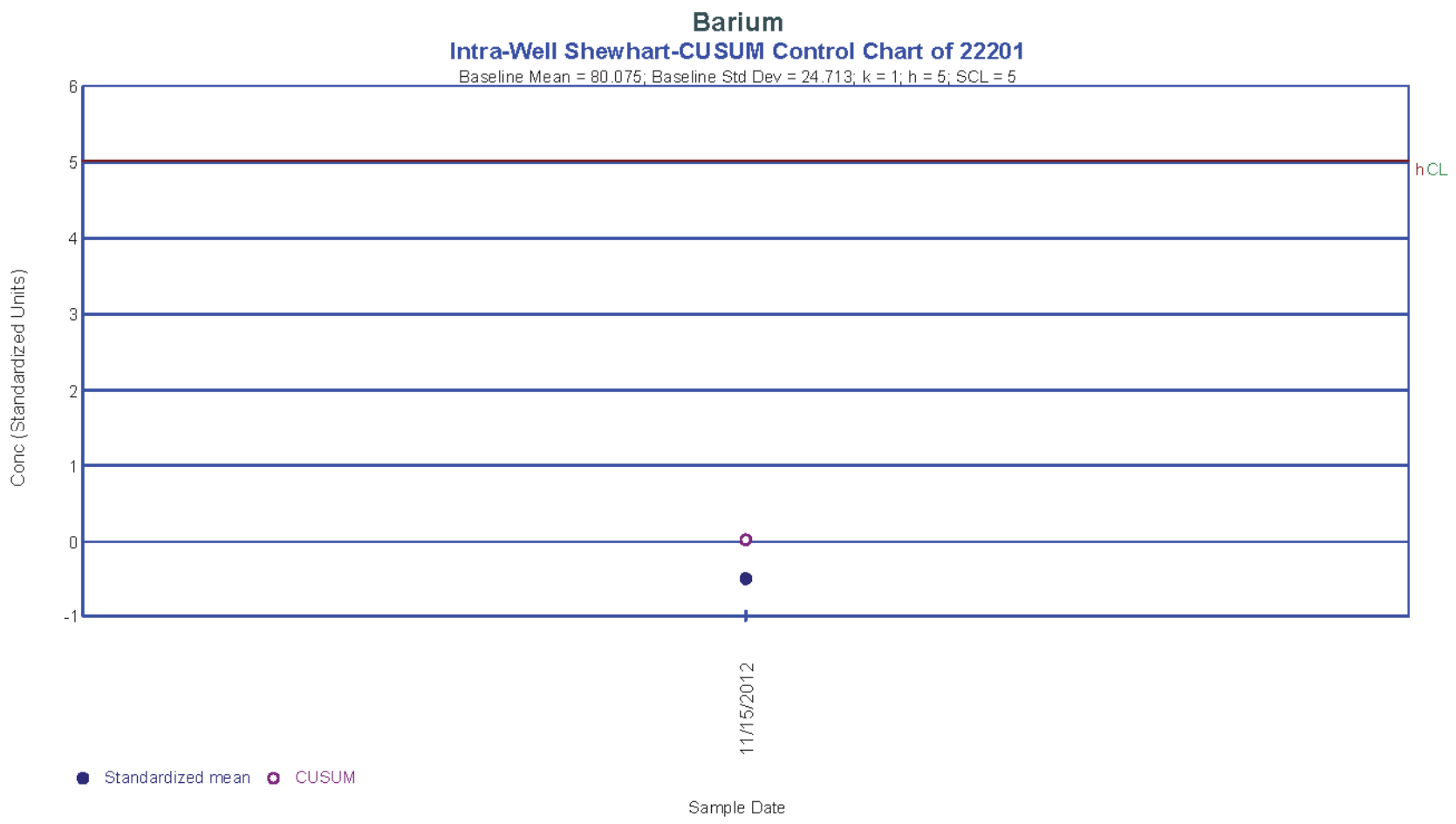


Figure A.5.1–32. Intra-Well Shewhart-CUSUM Control Chart (Barium 22201)

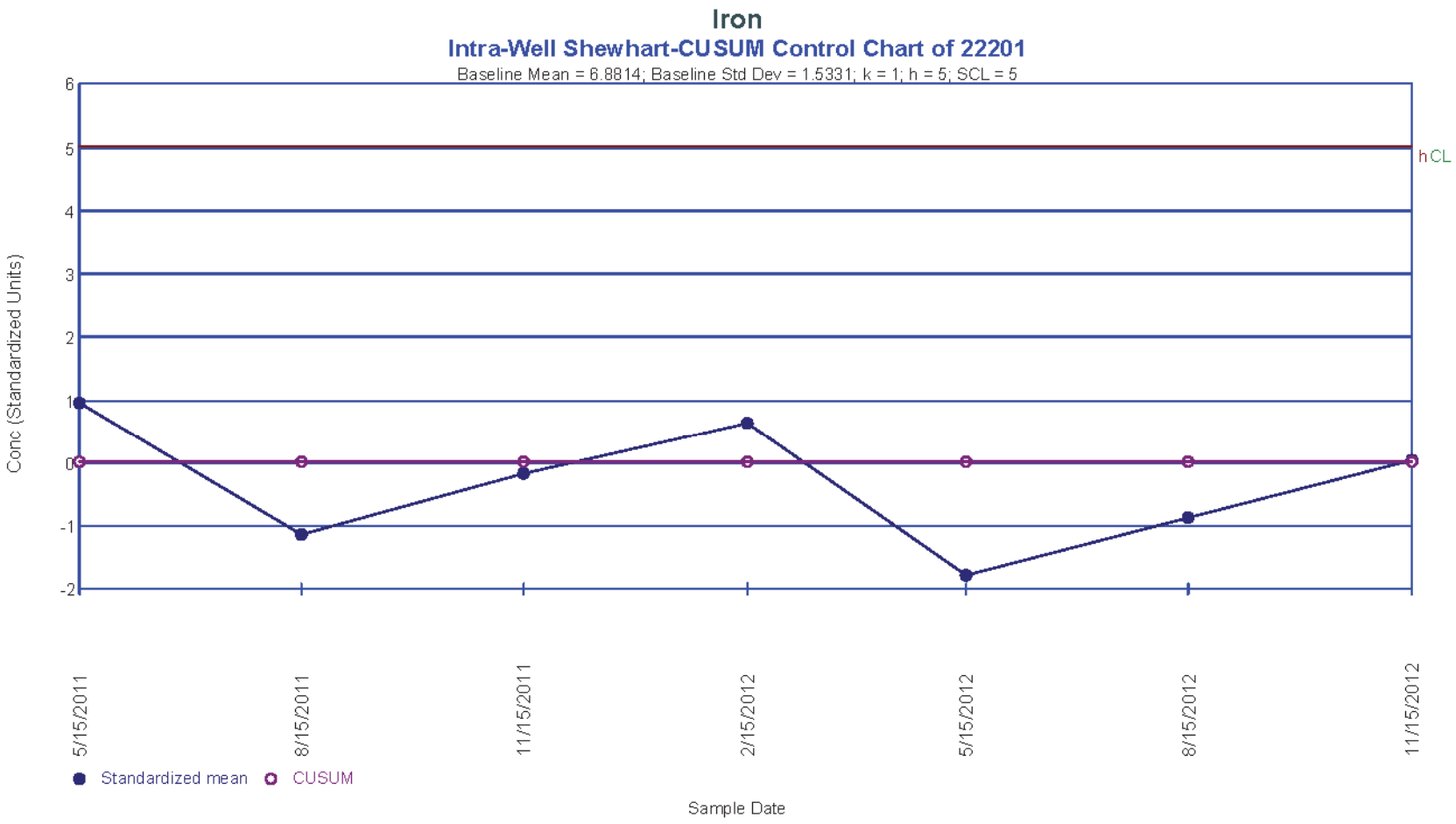


Figure A.5.1–33. Intra-Well Shewhart-CUSUM Control Chart (Iron 22201)

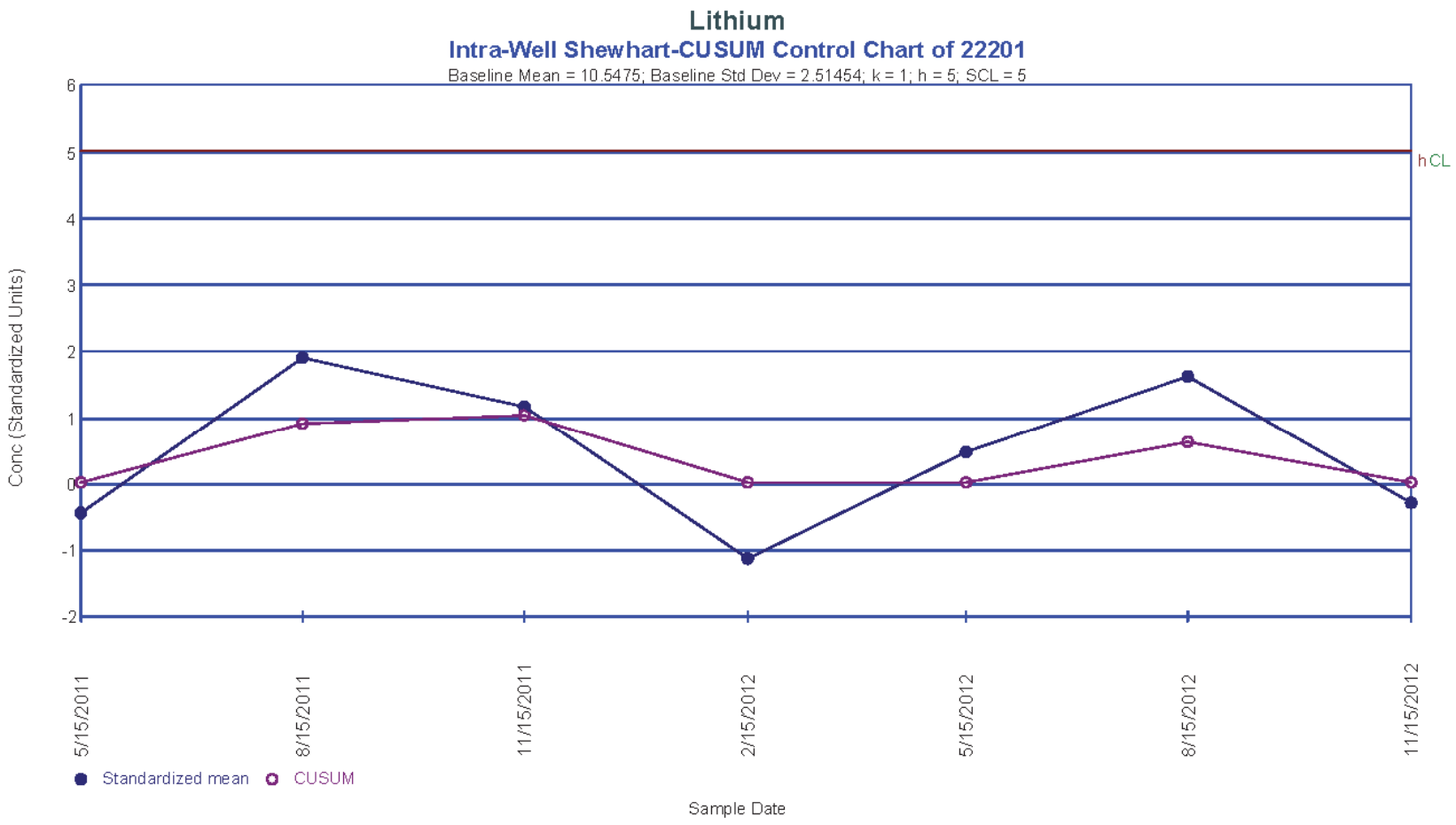


Figure A.5.1–34. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22201)

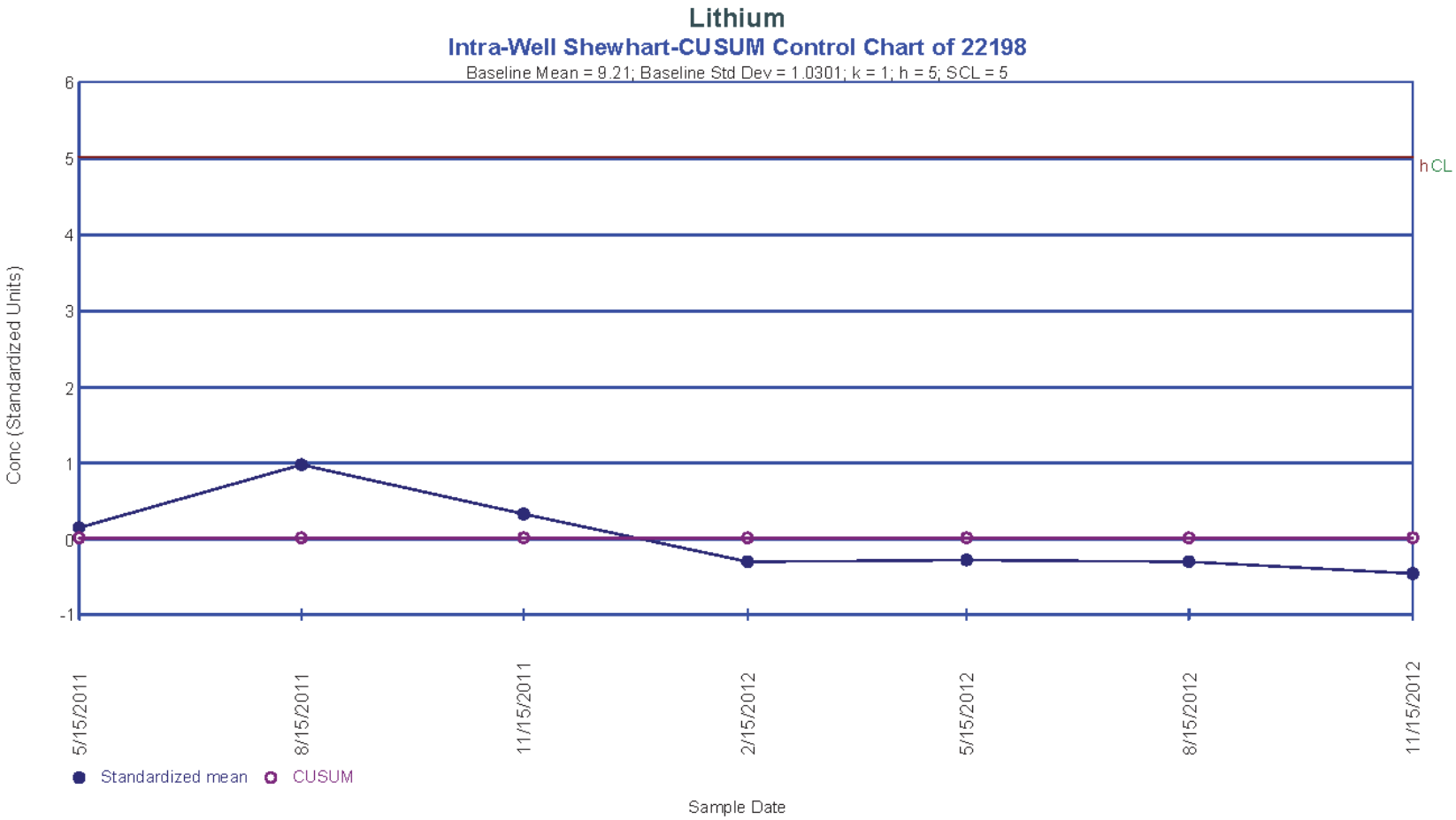


Figure A.5.1–35. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22198)

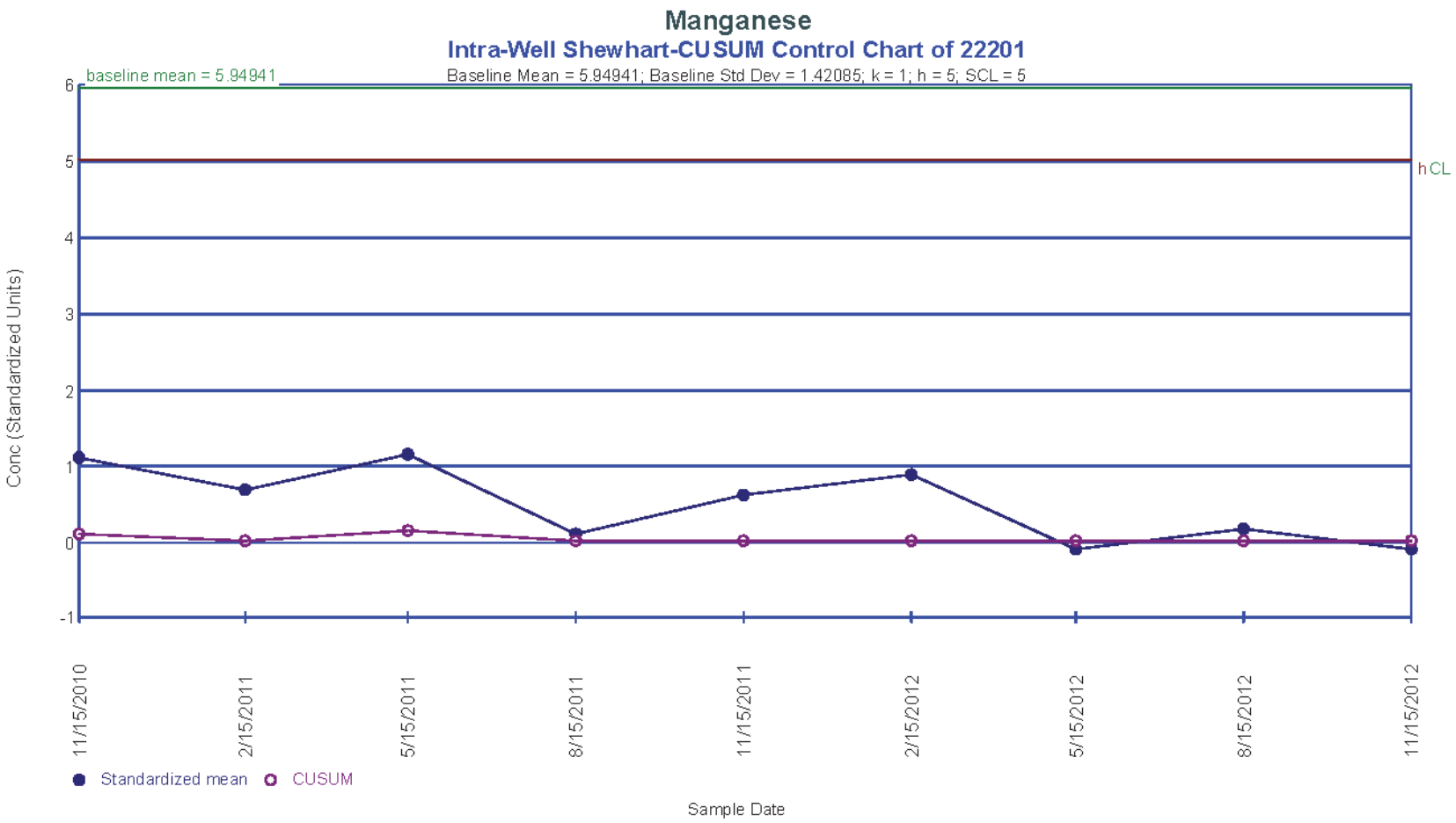


Figure A.5.1–36. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22201)

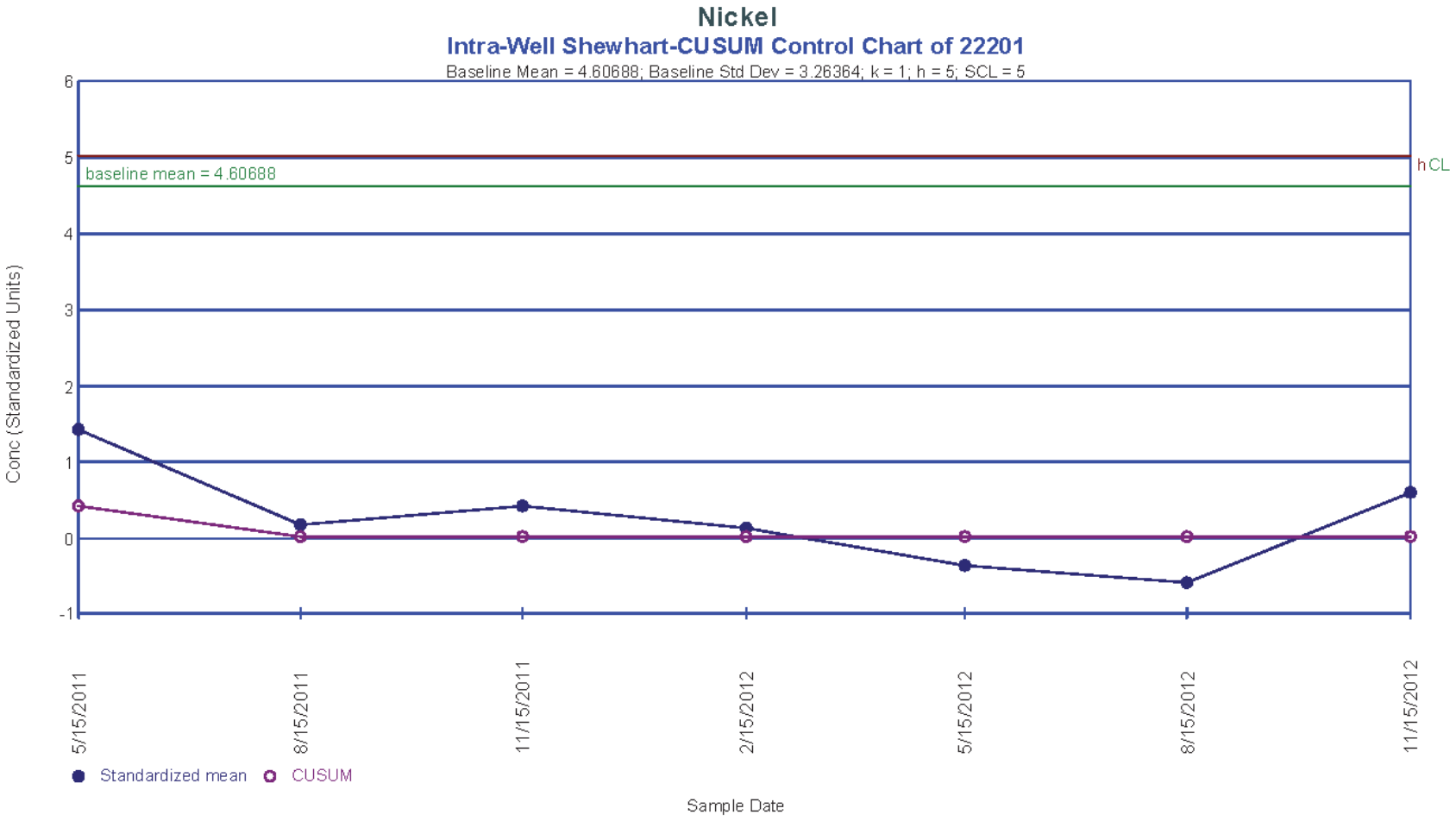
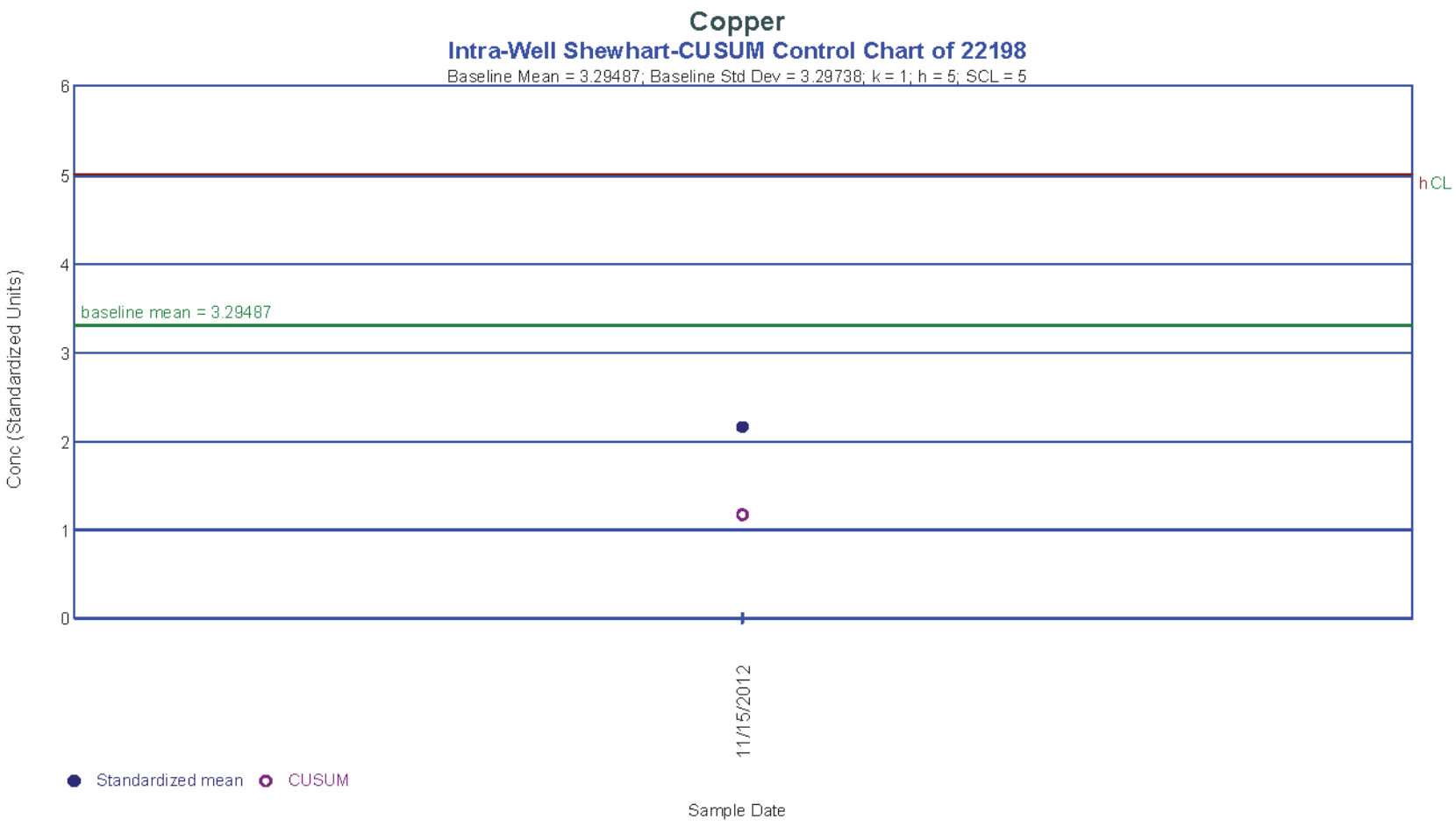


Figure A.5.1–37. Intra-Well Shewhart-CUSUM Control Chart (Nickel 22201)



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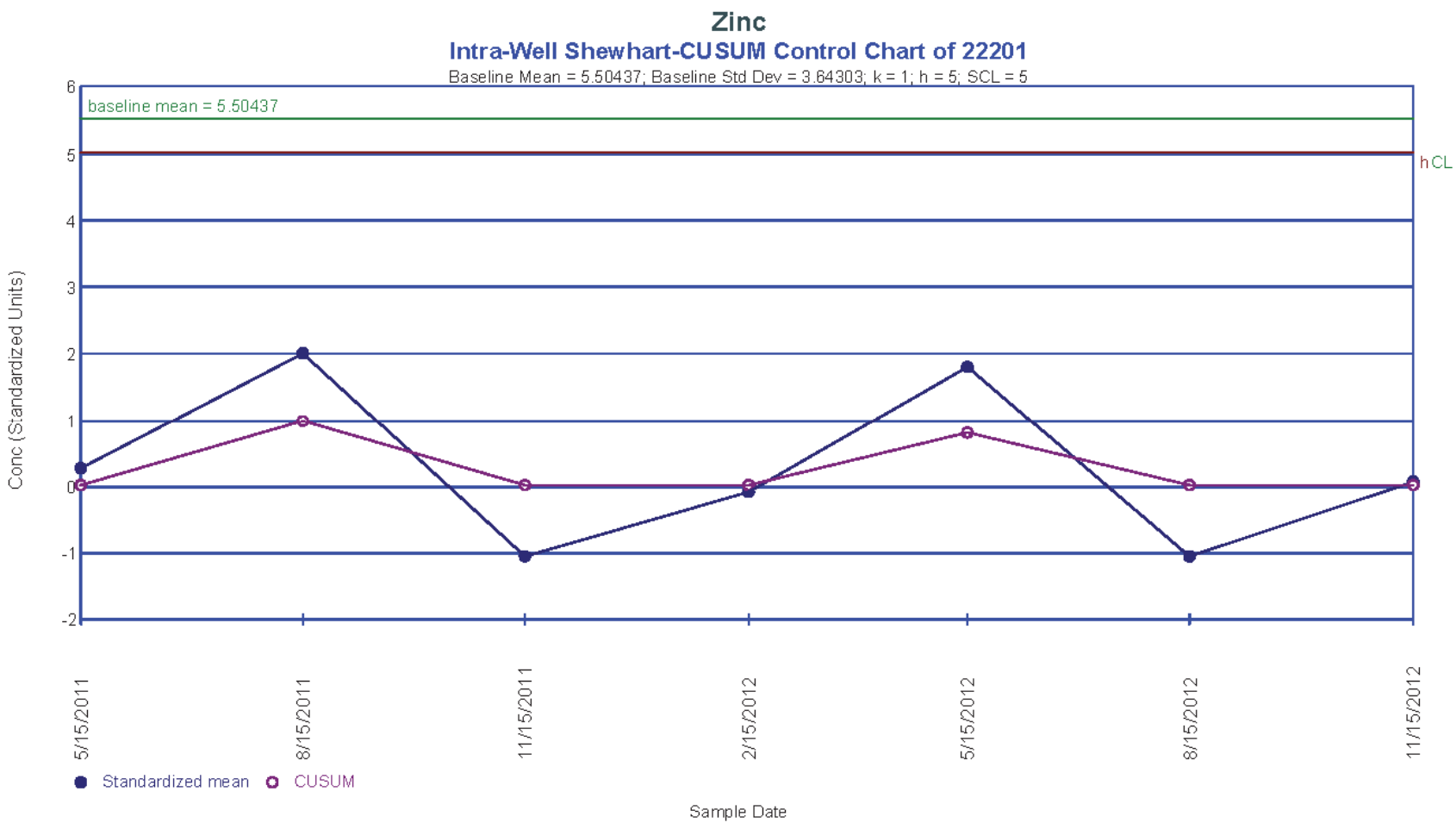

Figure A.5.1–39. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22201)

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Sub-attachment A.5.2

Cell 2

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The following information is provided in this sub-attachment:

- Quarterly monitoring summary statistics (refer to Table A.5.2–1)
- Annual LCS sample summary information for detected parameters (refer to Table A.5.2–2)
- LCS monthly accumulation volumes (refer to Figure A.5.2–1)
- LDS monthly accumulation volumes (refer to Figure A.5.2–2)
- OSDF horizontal till well 12339 water yield (refer to Figure A.5.2–3)
- GMA water levels and uranium concentration versus time (refer to Figures A.5.2–4 and A.5.2–5)
- Plots of concentration versus time (refer to Figures A.5.2–6A to A.5.2–28B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.2–29)
- Control charts (refer to Figures A.5.2–30 to A.5.2–39)

A.5.2.1 Quarterly Monitoring Results

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within the cell is sampled in the LCS and LDS. Water quality beneath the cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present the results.

In 2012, 23 parameters were sampled quarterly in the LCS, LDS, and GMA wells of each cell. HTWs in all cells were sampled quarterly for arsenic, uranium, sodium, and sulfate.

As shown in Table A.5.2–1 and summarized below, five parameters (uranium, arsenic, TDS, boron, and potassium) have upward trends in the HTW and/or the GMA wells based on the Mann-Kendall test for trend.

Parameters with upward concentration trends in the HTW and GMA Wells of Cell 2

Parameter	HTW[a] 12339	GMA-U[a] 22200	GMA-D[a] 22199
Uranium	Up	Up	
Arsenic			Up
TDS		Up	
Boron		Up	Up
Potassium		Up	

[a] HTW = horizontal till well, GMA-U = upgradient Great Miami Aquifer, GMA-D = downgradient Great Miami Aquifer; TDS = total dissolved solids. No entry indicates that the trend was not up.

The (uranium-sodium) bivariate plot for the Cell 2 LCS, LDS, and HTW is provided in Figure A.5.2–29. The plot shows that the chemical signature for uranium-sodium in the LCS LDS, and HTW are separate and distinct; indicating that mixing between the horizons is not occurring. Therefore, upward concentration trends measured beneath Cell 2 (i.e., in the HTW

and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

A.5.2.2 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background. The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 2009) defines the process of creating a Shewart-CUSUM control chart. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected, the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared "out of control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit. Usually, two parameters are used to compute standardized limits; the decision value (h) and the SCL.

A minimum of eight samples are recommended for use in ChemStat software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat software plots both a CUSUM control limit (h) and a SCL on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL.

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat software though, by default, plots both the SCL and CUSUM (h) control limits on the charts. As a "work-a-round", the SCL limit was defined as 5 to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

As shown in Table A.5.2–1 in gray shading, six parameters in the HTW and/or GMA wells of Cell 2 meet the criteria for control charts (i.e., more than eight samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 10 control charts.

These 10 control charts are presented in Figures A.5.2–30 to A.5.2–39. All of the control charts for Cell 2 (with the exception of Manganese in well 22200) indicate "in control" conditions. The very last sample collected in 2012 at well 22200 was responsible for the "out of control" designation.

Parameter and Monitoring Point[a]	Assessment	Figure Number
Iron in the GMA-U	In Control	A.5.2–30
Iron in the GMA-D	In Control	A.5.2–31
Lithium in the GMA-U	In Control	A.5.2–32
Lithium in the GMA-D	In Control	A.5.2–33
Manganese in the GMA-U	Out of Control	A.5.2–34
Manganese in the GMA-D	In Control	A.5.2–35
Sodium in the GMA-U	In Control	A.5.2–36
TDS in the GMA-D	In Control	A.5.2–37
Zinc in the GMA-U	In Control	A.5.2–38
Zinc in the GMA-D	In Control	A.5.2–39

[a] TDS = total dissolved solids; GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer

A.5.2.3 Annual LCS Sample Results

Annual LCS sampling results for Cell 2 are provided in Table A.5.2–2 for those parameters that have been detected at least once and are not being sampled quarterly. No new Appendix I or PCB parameters were detected in the LCS of Cell 2 in 2012.

A.5.2.4 Summary and Conclusions

- Five parameters monitored quarterly have an upward concentration trend in the HTW and/or GMA wells of Cell 2: uranium, arsenic, TDS, boron, and potassium.
- Separate and distinct chemical signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 2 indicate that water is not mixing between the horizons. Therefore, upward concentration trends beneath Cell 2 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell and not to cell performance.
- Ten control charts were constructed for Cell 2 parameters. All of the control charts exhibit "in control" conditions with the exception of manganese in the GMA-U Well (well 22200). The very last sample collected in 2012 at well 22200 was responsible for the "out of control" designation.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 2 in 2012.

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Table A.5.2–1. Summary Statistics for Cell 2

Parameter	Horizon	Location	# of Detects	# of Samples	Percent Detects	Min	Max	Avg	Std Deviation	Distribution Type	Trend	Serial Correlation	Outliers
Total Uranium (µg/L)	LCS	12339C	55	55	100	4.51	404	99.7	74.4	Log Normal	Up	Detected	
	LDS	12339D	31	31	100	4.08	71.0	14.3	14.0	Undefined	None	Detected	
	HTW	12339	55	56	98.2	ND	36.9	8.12	5.69	Undefined	Up	Detected	
	GMA-U	22200	45	62	72.58	ND	1.93	0.292	0.321	Undefined	Up	Not Detected	
	GMA-D	22199	61	63	96.8	ND	12.1	0.737	2.50	Undefined	None	Not Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12339C	27	27	100	60.5	730	576	176	Undefined	Up	Not Detected	
	LDS	12339D	6	6	100	131	240	193	42	Normal	None	Not Detected	
	GMA-U	22200	8	8	100	401	426	414	10	Normal	None	Not Detected	
	GMA-D	22199	8	8	100	340	378	357	14	Normal	None	Not Detected	
Chloride (mg/L)	LCS	12339C	27	27	100	3.95	41.2	13.7	6.2	Undefined	Up	Detected	
	LDS	12339D	6	6	100	44	112	71.6	26.7	Normal	None	Not Detected	
	GMA-U	22200	8	8	100	31.5	42.8	38.2	3.6	Normal	None	Not Detected	
	GMA-D	22199	8	8	100	21.6	27.2	23.9	1.8	Normal	None	Not Detected	
Nitrate, Nitrite (mg/L)	LCS	12339C	24	37	64.9	ND	4.1	0.144	1.19	Undefined	Down	Detected	
	LDS	12339D	8	9	88.9	ND	7.45	3.40	2.18	Normal	None	Not Detected	
	GMA-U	22200	0	8	0	ND	NA	Insuff	Insuff	Insufficient	Insufficient	Insufficient	
	GMA-D	22199	0	8	0	ND	NA	Insuff	Insuff	Insufficient	Insufficient	Insufficient	
Sulfate (mg/L)	LCS	12339C	44	44	100	155	1870	1580	360	Undefined	Up	Detected	
	LDS	12339D	14	14	100	2290	2850	3520	970	Normal	Up	Detected	8110(Q3-05)
	HTW	12339	34	34	100	413	850	625	99	Normal	Down	Detected	
	GMA-U	22200	39	39	100	61.1	434	194	99	LogNormal	Down	Detected	
	GMA-D	22199	39	39	100	101	540	179	101	Undefined	None	Not Detected	
Total Dissolved Solids (mg/L)	LCS	12339C	36	36	100	557	3430	2820	970	Undefined	Up	Detected	
	LDS	12339D	8	8	100	1890	9530	5640	2720	Normal	Up	Detected	
	GMA-U	22200	15	15	100	545	857	662	103	Normal	Up	Not Detected	
	GMA-D	22199	15	15	100	576	818	658	73	Normal	None	Not Detected	
Total Organic Carbon (mg/L)	LCS	12339C	45	55	81.8	ND	6.6	2.66	1.36	Undefined	Up	Detected	
	LDS	12339D	23	31	74.2	ND	26.1	3.77	4.67	LogNormal	Down	Detected	
	GMA-U	22200	50	62	80.6	ND	40.1	1.84	5.80	Undefined	None	Not Detected	
	GMA-D	22199	46	62	74.2	ND	3.7	1.52	0.62	Undefined	None	Not Detected	16.5(Q3-97)10.5(Q4-97)48.1(Q2-98) 9.68(Q1-00)
Total Organic Halogens (mg/L)	LCS	12339C	27	56	48.2	ND	0.0826	0.0186	0.0197	LogNormal	None	Detected	
	LDS	12339D	11	32	34.4	ND	0.069	0.012	0.012	Undefined	Down	Not Detected	
	GMA-U	22200	18	62	29.0	ND	0.177	0.0047	0.0278	Undefined	Down	Detected	
	GMA-D	22199	14	62	22.6	ND	0.0272	0.0045	0.0058	Undefined	Down	Detected	77.5(Q2-00)67(Q2-10)
Arsenic (mg/L)	LCS	12339C	19	32	59.4	ND	0.225	0.00718	0.0633	Undefined	Up	Detected	
	LDS	12339D	3	6	50.0	ND	0.00842	0.0046	0.00308	Normal	None	Not Detected	
	HTW	12339	2	24	8.3	ND	0.025	Insuff	Insuff	Undefined	None	Not Detected	
	GMA-U	22200	3	15	20.0	ND	0.0355	0.0025	Insuff	Undefined	None	Not Detected	
	GMA-D	22199	6	28	21.4	ND	0.0429	0.0025	0.0106	Undefined	Up	Detected	
Barium (mg/L)	LCS	12339C	27	27	100	0.0362	0.283	0.0658	0.0713	Undefined	None	Not Detected	
	LDS	12339D	6	6	100	0.0167	0.0221	0.0196	0.0020	Normal	None	Not Detected	
	GMA-U	22200	8	8	100	0.0811	0.156	0.108	0.025	Normal	None	Not Detected	
	GMA-D	22199	8	8	100	0.0641	0.131	0.0882	0.0251	Normal	None	Not Detected	

Table A.5.2−1 (continued). Summary Statistics for Cell 2

Parameter	Horizon	Location	# of Detects	# of Samples	Percent Detects	Min	Max	Avg	Std Deviation	Distribution Type	Trend	Serial Correlation	Outliers
Boron (mg/L)	LCS	12339C	56	56	100	0.207	4.78	2.40	1.05	Undefined	Up	Detected	
	LDS	12339D	31	31	100	0.289	2.22	0.411	0.355	Undefined	None	Not Detected	
	GMA-U	22200	50	62	80.6	ND	0.0982	0.051	0.019	Undefined	Up	Detected	
	GMA-D	22199	53	62	85.5	ND	0.0775	0.0508	0.0156	Normal	Up	Detected	
Calcium (mg/L)	LCS	12339C	27	27	100	165	1320	604	250	Normal	None	Detected	
	LDS	12339D	6	6	100	420	546	470	43	Undefined	None	Not Detected	
	GMA-U	22200	8	8	100	130	205	161	29	Normal	None	Not Detected	
	GMA-D	22199	8	8	100	132	193	157	24	Normal	None	Not Detected	
Cobalt (mg/L)	LCS	12339C	28	32	87.5	ND	0.306	0.0939	0.0702	LogNormal	None	Detected	
	LDS	12339D	1	6	16.7	ND	0.0035	Insuff	Insuff	Undefined	None	Not Detected	
	GMA-U	22200	0	15	0	ND	NA	Insuff	Insuff	Insufficient	Insufficient	Insufficient	
	GMA-D	22199	0	15	0	ND	NA	Insuff	Insuff	Insufficient	Insufficient	Insufficient	
Copper (mg/L)	LCS	12339C	20	28	71.4	ND	0.0328	0.0085	0.0084	Undefined	None	Detected	
	LDS	12339D	4	6	66.7	ND	0.0221	0.0143	0.0061	Normal	None	Not Detected	
	GMA-U	22200	6	8	75.0	ND	0.0144	0.0055	0.0045	Normal	Down	Detected	
	GMA-D	22199	6	8	75.0	ND	0.01	0.0045	0.0038	Normal	None	Not Detected	
Iron (mg/L)	LCS	12339C	31	32	96.9	ND	253	198	64	LogNormal	None	Not Detected	
	LDS	12339D	6	6	100	0.0774	3.61	1.15	1.38	Log Normal	None	Not Detected	
	GMA-U	22200	15	15	100	3.24	10	6.17	2.32	Normal	None	Not Detected	
	GMA-D	22199	15	15	100	3.21	5.82	4.17	0.63	Normal	None	Not Detected	
Lithium (mg/L)	LCS	12339C	24	24	100	0.377	0.984	0.601	0.207	Undefined	Up	Detected	
	LDS	12339D	6	6	100	0.226	0.541	0.394	0.113	Normal	None	Not Detected	
	GMA-U	22200	15	15	100	0.00363	0.00562	0.0045	0.0005	Normal	None	Not Detected	
	GMA-D	22199	15	15	100	0.00650	0.00878	0.0075	0.0006	Normal	None	Not Detected	
Magnesium (mg/L)	LCS	12339C	27	27	100	32.4	375	222	89	Normal	Up	Detected	
	LDS	12339D	6	6	100	393	640	515	96	Normal	None	Not Detected	
	GMA-U	22200	8	8	100	33.1	50.7	41.0	5.2	Normal	None	Not Detected	
	GMA-D	22199	8	8	100	38.0	54.8	40.0	6.8	Undefined	None	Not Detected	
Manganese (mg/L)	LCS	12339C	30	32	93.8	ND	12.7	1.92	3.79	Undefined	None	Detected	
	LDS	12339D	3	6	50.0	ND	0.812	0.896	Insuff	LogNormal	None	Not Detected	
	GMA-U	22200	17	17	100	0.204	0.742	0.367	0.153	LogNormal	None	Not Detected	
	GMA-D	22199	27	28	96.4	ND	0.791	0.315	0.151	LogNormal	None	Not Detected	
Nickel (mg/L)	LCS	12339C	32	32	100	0.00495	0.421	0.0737	0.0891	LogNormal	None	Detected	
	LDS	12339D	5	6	83.3	ND	0.0215	0.0078	0.0078	LogNormal	None	Not Detected	
	GMA-U	22200	0	15	0	ND	NA	Insuff	Insuff	Insufficient	Insufficient	Insufficient	
	GMA-D	22199	6	28	21.4	ND	0.0066	0.0008	0.0016	Undefined	None	Detected	
Potassium (mg/L)	LCS	12339C	27	27	100	3.93	51.4	22.4	14.9	Undefined	Up	Detected	
	LDS	12339D	6	6	100	29.8	48.6	39.0	6.9	Normal	None	Not Detected	
	GMA-U	22200	8	8	100	1.5	2.14	1.79	0.24	Normal	Up	Not Detected	
	GMA-D	22199	8	8	100	1.34	1.58	1.47	0.10	Normal	None	Not Detected	

Table A.5.2−1 (continued). Summary Statistics for Cell 2

Parameter	Horizon	Location	# of Detects	# of Samples	Percent Detects	Min	Max	Avg	Std Deviation	Distribution Type	Trend	Serial Correlation	Outliers
Selenium (mg/L)	LCS	12339C	12	32	37.5	ND	0.0522	0.0097	0.0127	LogNormal	None	Not Detected	
	LDS	12339D	5	6	83.3	ND	0.0191	0.0104	0.0060	Normal	None	Not Detected	
	GMA-U	22200	0	15	0	ND	NA	Insuff	Insuff	Insufficient	Insufficient	Insufficient	
	GMA-D	22199	0	15	0	ND	NA	Insuff	Insuff	Insufficient	Insufficient	Insufficient	
Sodium (mg/L)	LCS	12339C	32	32	100	3.32	26.7	18.1	5.7	Normal	Up	Detected	
	LDS	12339D	6	6	100	664	1090	888	175	Normal	None	Not Detected	
	HTW	12339	24	24	100	40.9	119	56.8	24.4	Undefined	Down	Detected	
	GMA-U	22200	15	15	100	20.4	32.9	27.4	3.9	Normal	None	Not Detected	
	GMA-D	22199	15	15	100	13.3	19.5	16.4	1.8	Normal	Down	Detected	
Zinc (mg/L)	LCS	12339C	23	32	71.9	ND	0.353	0.0669	0.0824	LogNormal	None	Detected	
	LDS	12339D	6	6	100	0.0747	0.284	0.0894	0.0811	Undefined	None	Not Detected	
	GMA-U	22200	12	15	80	ND	0.0377	0.0148	0.0100	Normal	None	Not Detected	
	GMA-D	22199	19	28	67.9	ND	0.0255	0.0061	0.0045	LogNormal	None	Not Detected	

Note 1: Shading identifies a horizontal till well or Great Miami Aquifer well, with more than 8 samples, normal or lognormal distribution, no trend, and no serial correlation. These wells meet control chart criteria.

Note 2: Data used in this table has been standardized to quarterly.

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]ND = not detected; NA = not applicable

[c]Averages were determined based on the distribution assumption.

[d]Insufficient is used for Distribution Type, Trend, or Serial Correlation whenever there is not enough data to run the test.

[e]Data distribution based on the Shapiro-Wilk statistic.

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[f]Trend based on nonparametric Mann-Kendall procedure.

[g]Serial correlation based on Rank Von Neumann test.

[h]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 25).

[i]Q = quarterly

Table A.5.2–2. Cell 2 Annual LCS Sample Summary Information for Detected Parameters

PARAMETER (UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	DETECTED IN 2012	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (SAMPLES>GW BACKGROUND)	PW BACKGROUND[a,b,e] (SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (SAMPLES>MAX PW)
General Chemistry											
Ammonia (mg/L)	15	11	73.3	Yes	0.03	4.5	0.732	-	4.2 mg/L(1)	4.34 mg/L(1)	220 mg/L(0)
Inorganic											
Beryllium (mg/L)	15	2	13.3	No	0.0000674	0.00012	0.0001	0.004 mg/L(0)	-	-	0.0343 mg/L(0)
Cadmium (mg/L)	15	4	26.7	No	0.00014	0.00084	0.0004	0.014 mg/L(0)	0.014 mg/L(0)	-	0.05 mg/L(0)
Chromium (mg/L)	15	6	40.0	No	0.0012	0.00365	0.0023	0.022 mg/L[g](0)	0.021 mg/L(0)	0.0046 mg/L(0)	0.818 mg/L(0)
Lead (mg/L)	15	2	13.3	No	0.00066	0.0222	0.0114	0.015 mg/L(1)	0.022 mg/L(1)	0.0016 mg/L(1)	0.0114 mg/L(1)
Mercury (mg/L)	29	2	6.9	No	0.00000024	0.00047	0.0002	0.002 mg/L(0)	-	-	0.0018 mg/L(0)
Silver (mg/L)	15	1	6.7	No	0.00014	-	-	0.05 mg/L(0)	0.0117 mg/L(0)	0.0031 mg/L(0)	0.264 mg/L(0)
Thallium (mg/L)	15	2	13.3	No	0.0007	0.00756	0.0041	-	-	-	0.0028 mg/L(1)
Radionuclide											
Technetium-99 (pCi/L)	31	7	22.6	No	1.81	18.3	9.92	94 pCi/L(0)	22 pCi/L(0)	30 pCi/L(0)	6130 pCi/L(0)
Organic											
4-Nitroaniline (ug/L)	28	1	3.6	No	1.01	-	-	-	-	-	-

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information.

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on hexavalent chromium from Operable Unit 5 Record of Decision, Table 9-4.

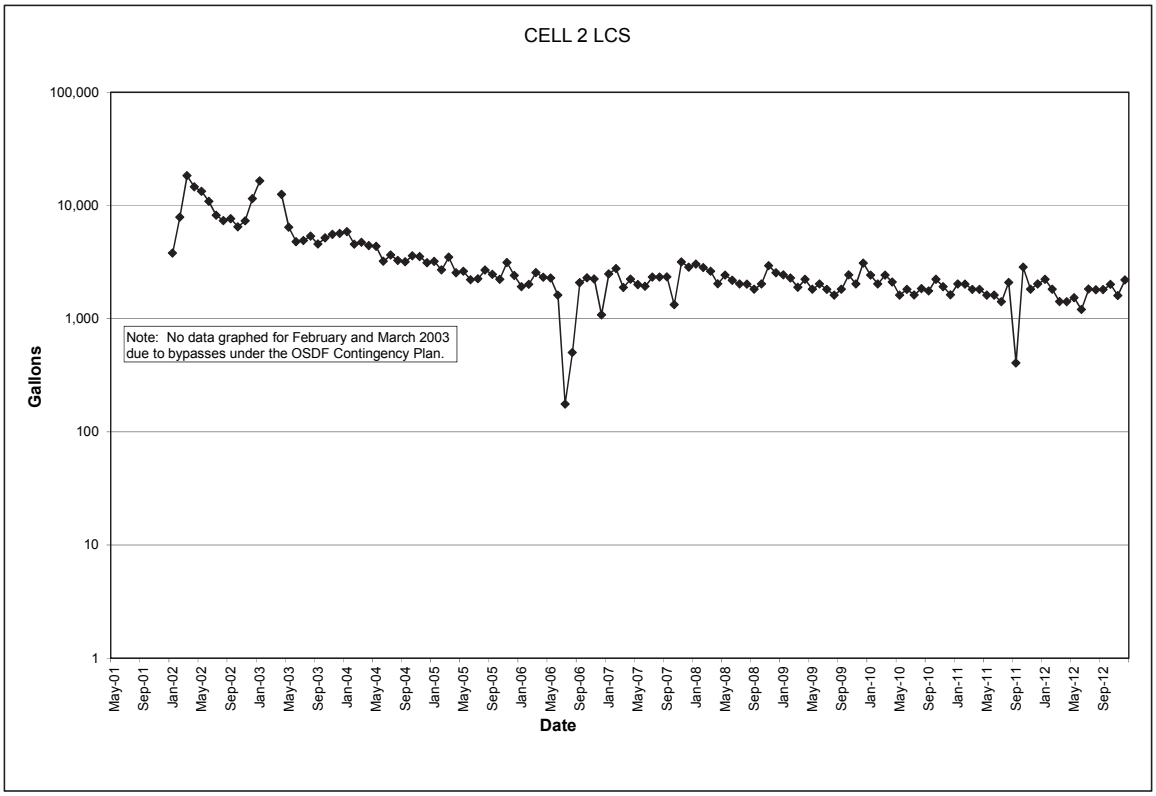


Figure A.5.2–1. Monthly Accumulation Volumes for Cell 2 LCS

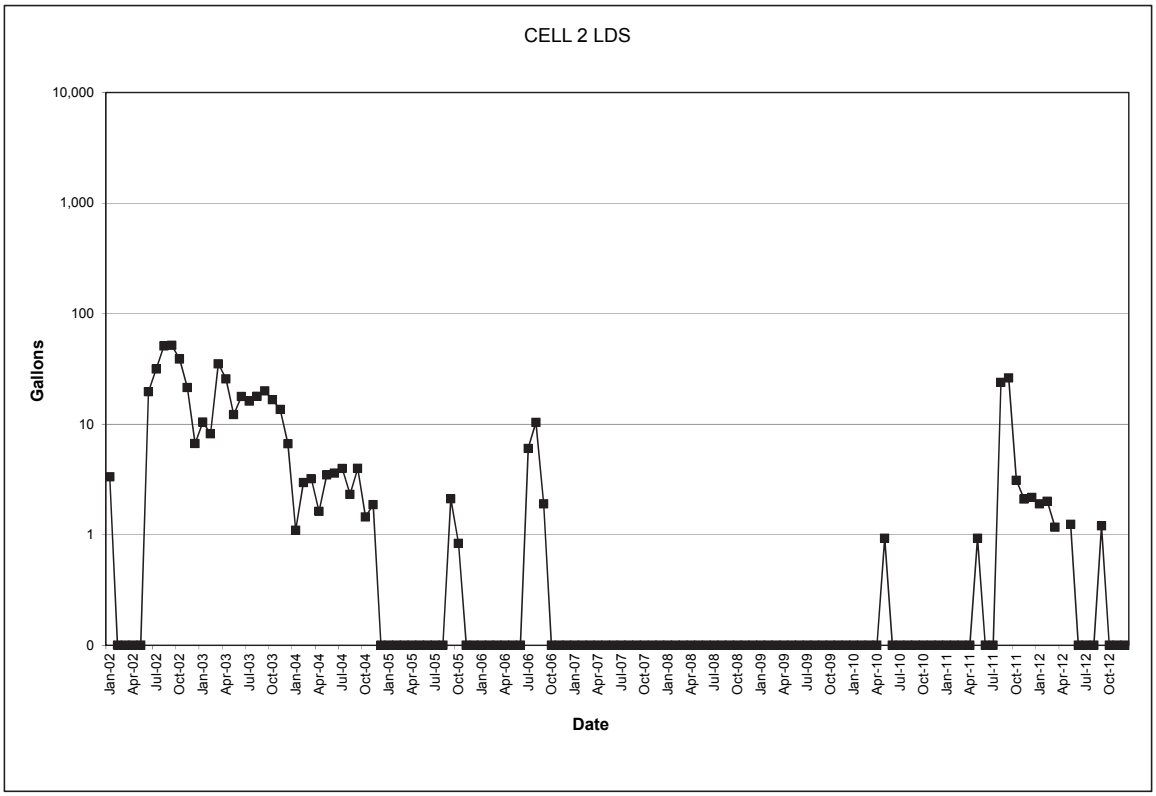
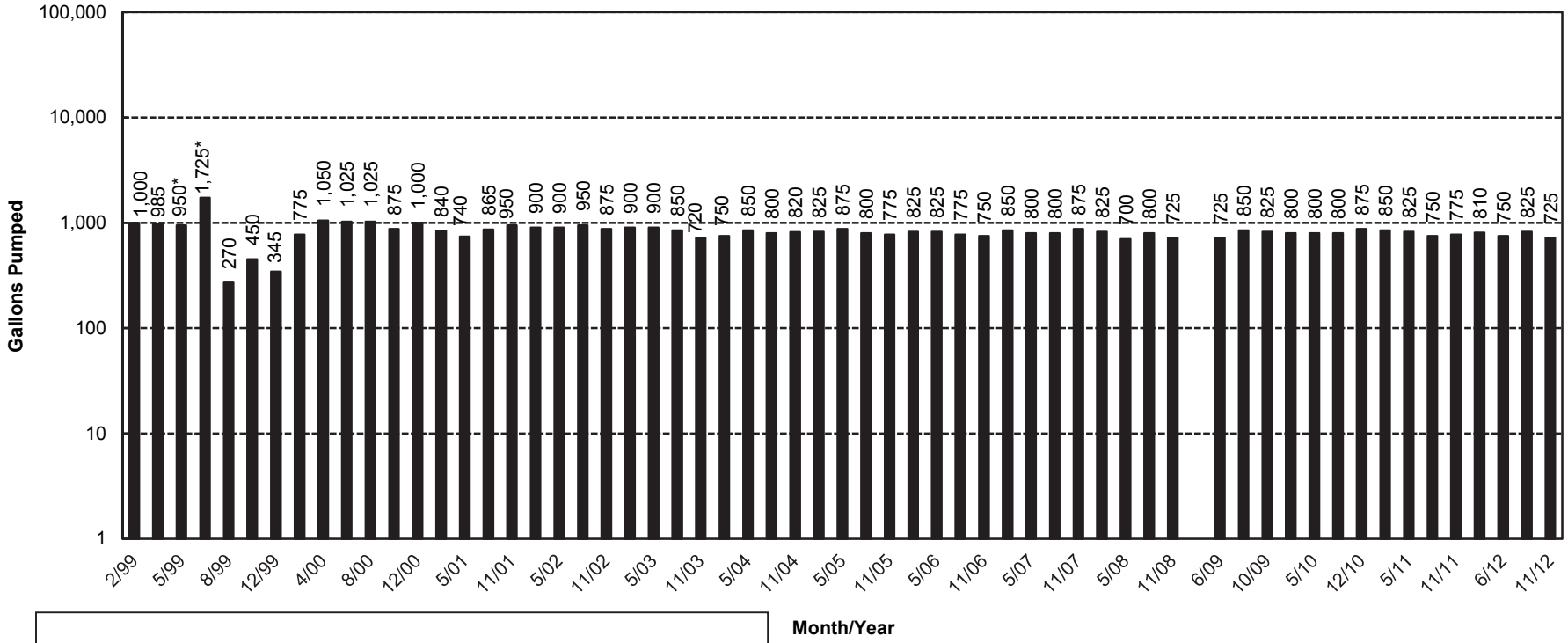


Figure A.5.2–2. Monthly Accumulation Volumes for Cell 2 LDS



12339 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
1999:	5725	n=7	818
2000:	5750	n=6	958
2001:	3395	n=4	849
2002:	3625	n=4	906
2003:	3370	n=4	843
2004:	3220	n=4	805
2005:	3275	n=4	819
2006:	3175	n=4	1088
2007:	3325	n=4	831
2008:	3050	n=4	763
2009:	2400	n=3	800
2010:	3275	n=4	819
2011:	3200	n=4	800
2012:	3110	n=4	778
Overall:			832

*More than one purge of the well was completed during these months to help evaluate well yield.

Figure A.5.2–3. OSDF Horizontal Till Well 12339 (Cell 2) Water Yield

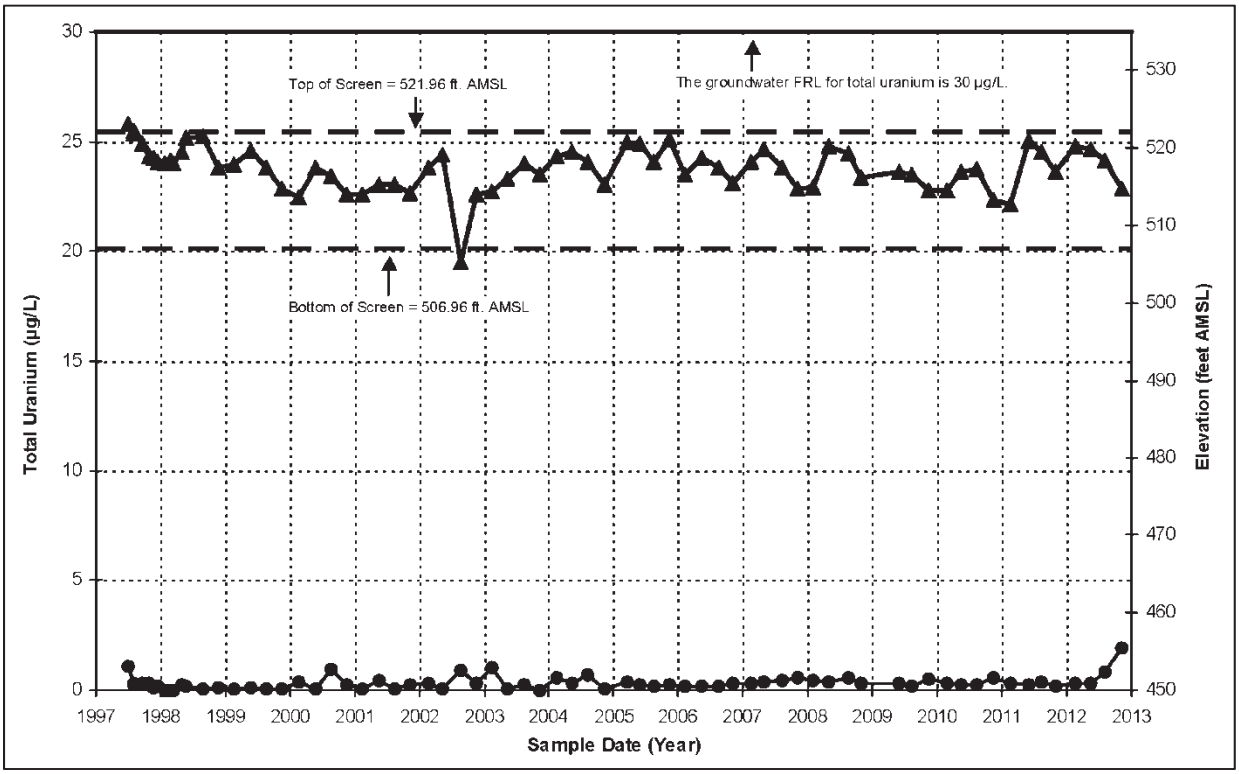


Figure A.5.2–4. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 2 Upgradient Monitoring Well 22200

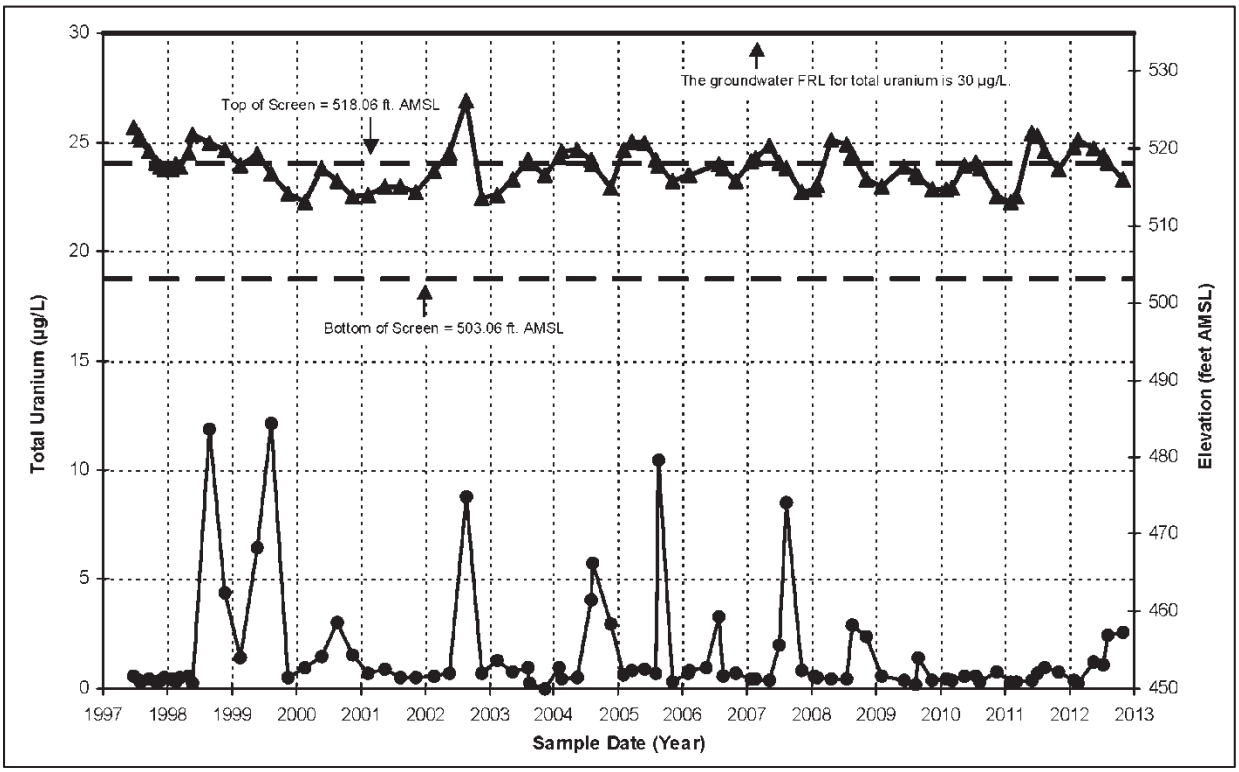


Figure A.5.2–5. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 2 Downgradient Monitoring Well 22199

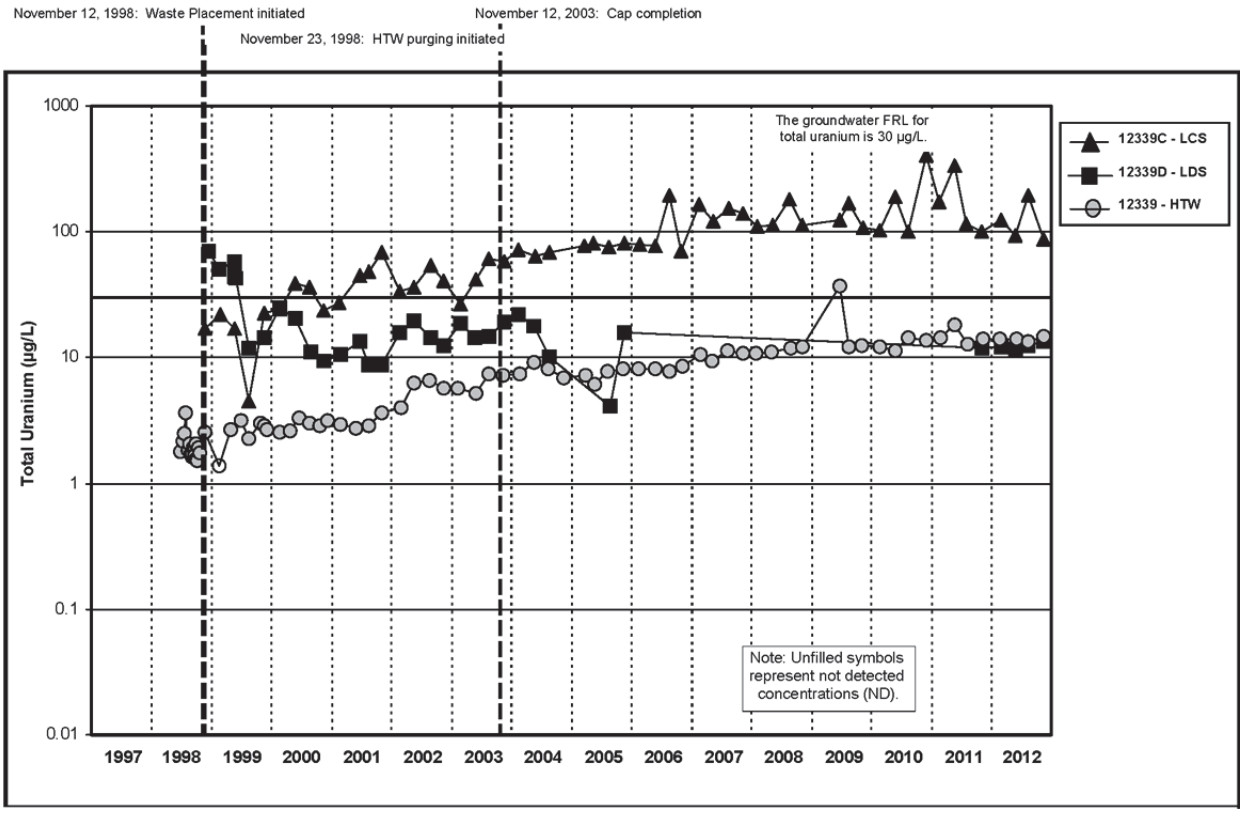


Figure A.5.2–6A. Cell 2 Total Uranium Concentration vs. Time Plot for LCS, LDS, and HTW

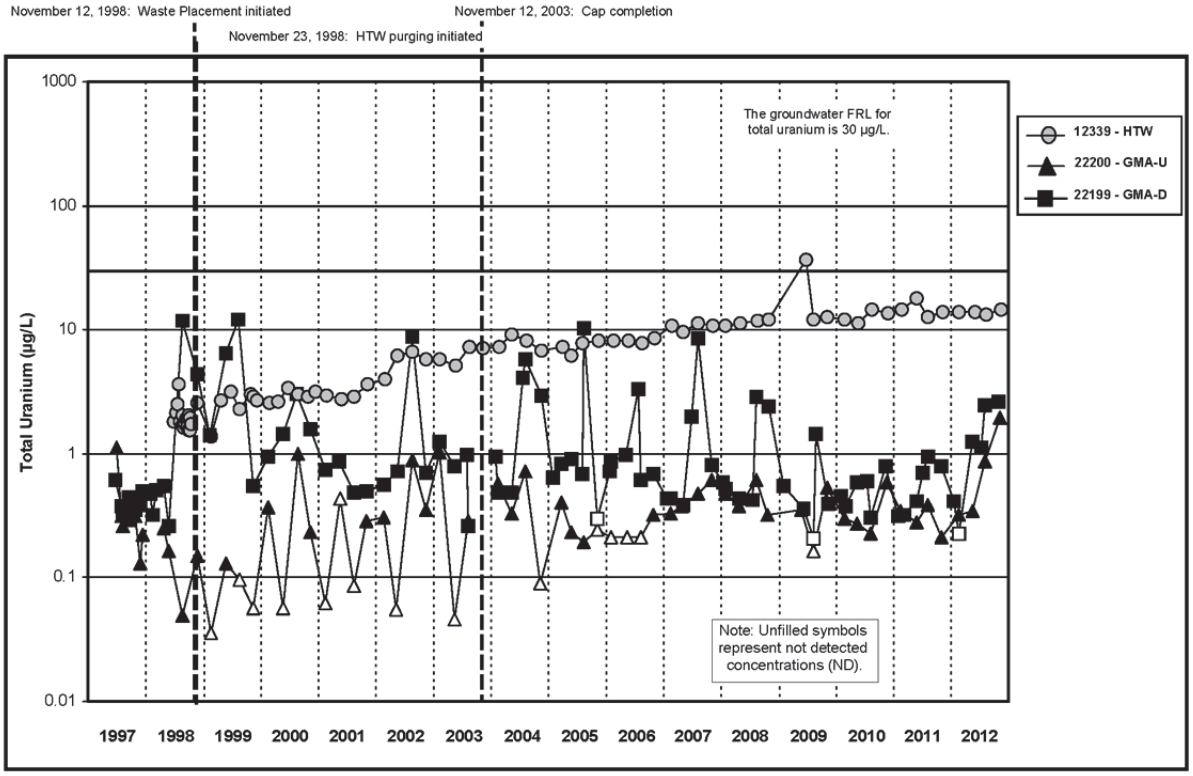


Figure A.5.2–6B. Cell 2 Total Uranium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

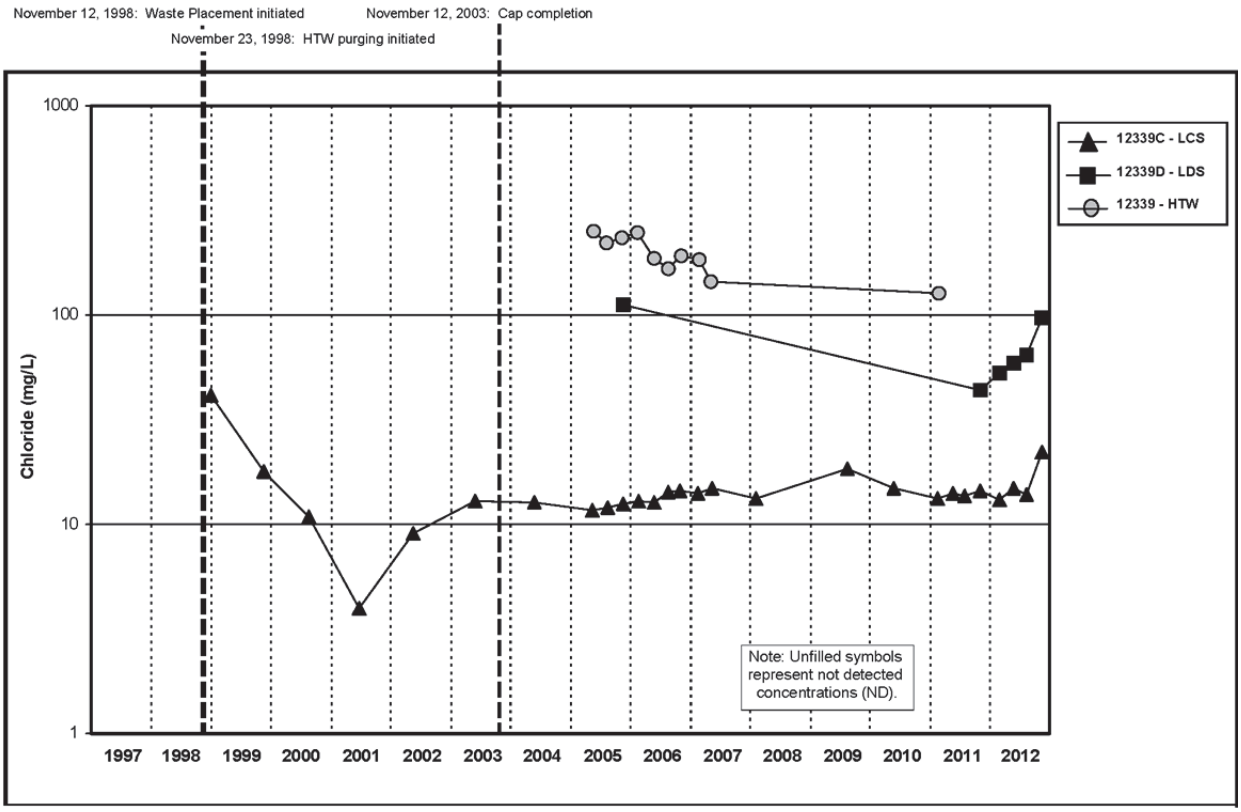


Figure A.5.2–7A. Cell 2 Chloride Concentration vs. Time Plot for LCS, LDS, and HTW

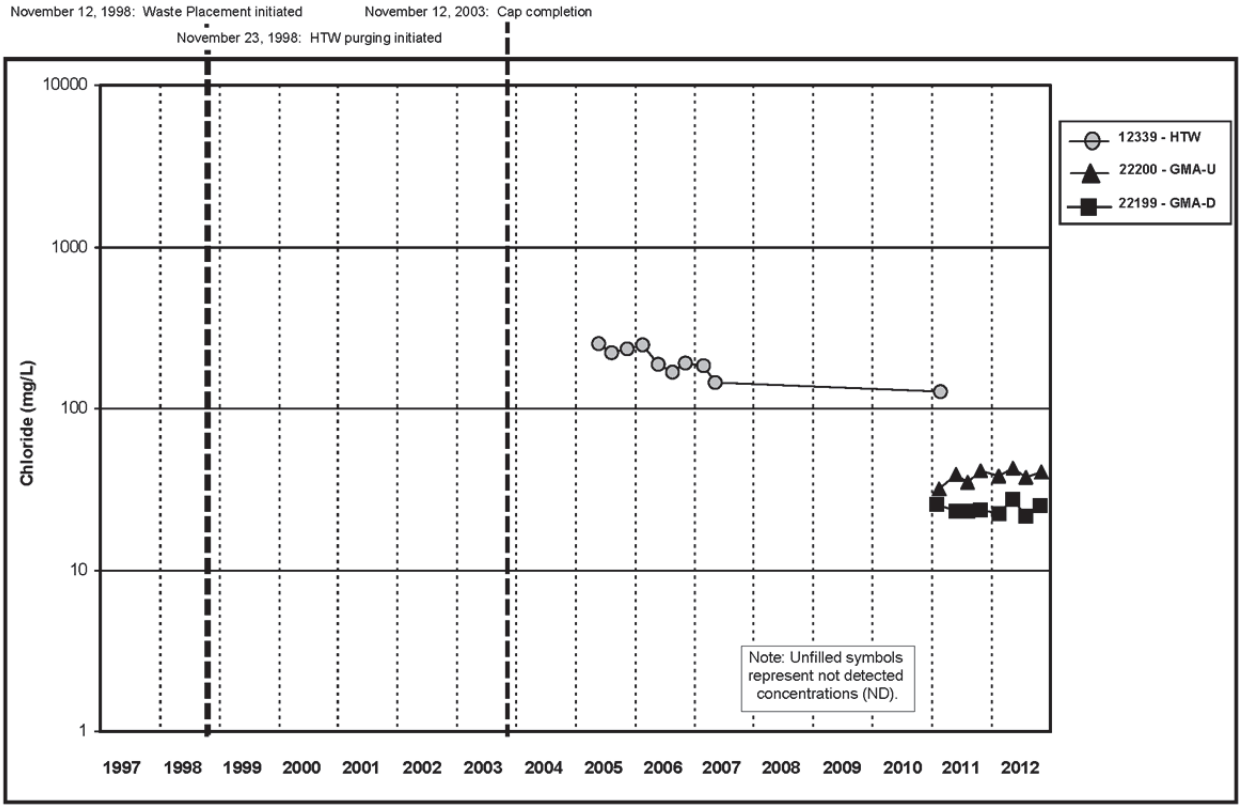


Figure A.5.2–7B. Cell 2 Chloride Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

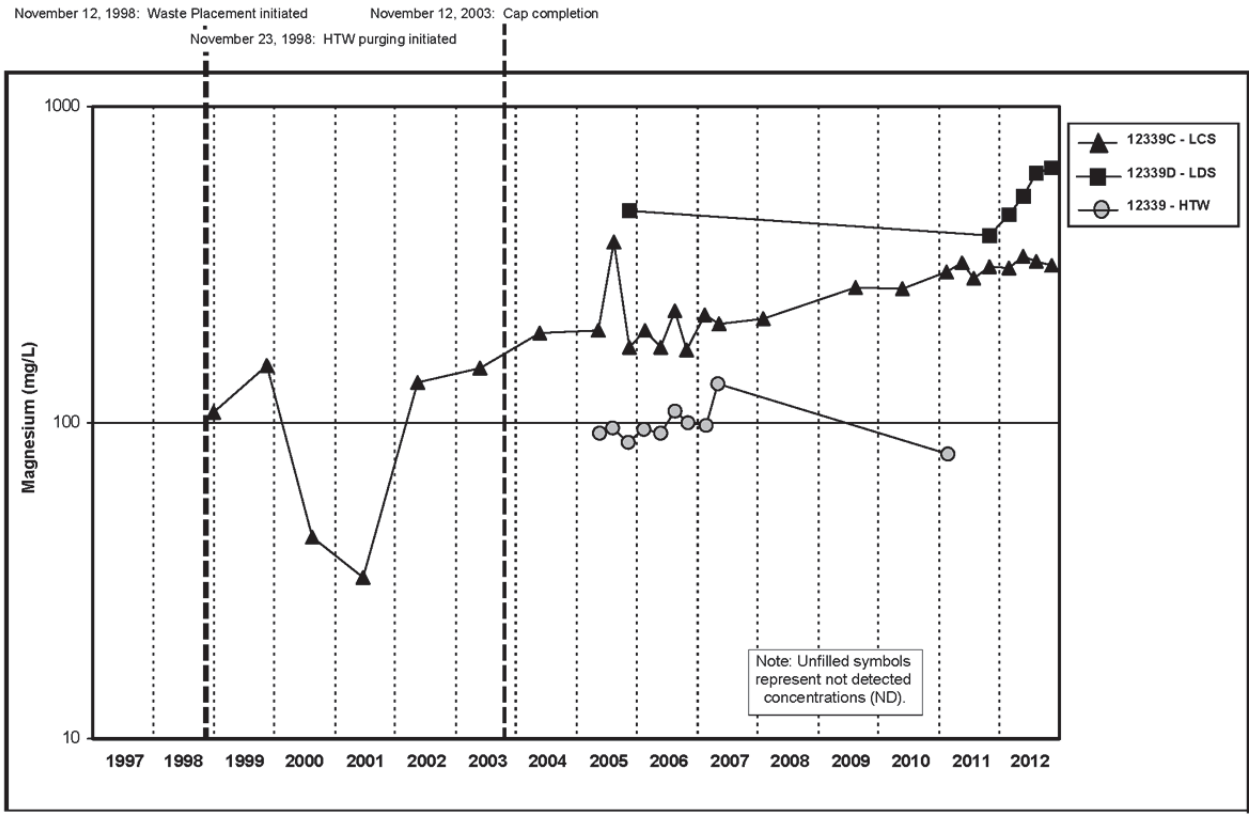


Figure A.5.2–8A. Cell 2 Magnesium Concentration vs. Time Plot for LCS, LDS, and HTW

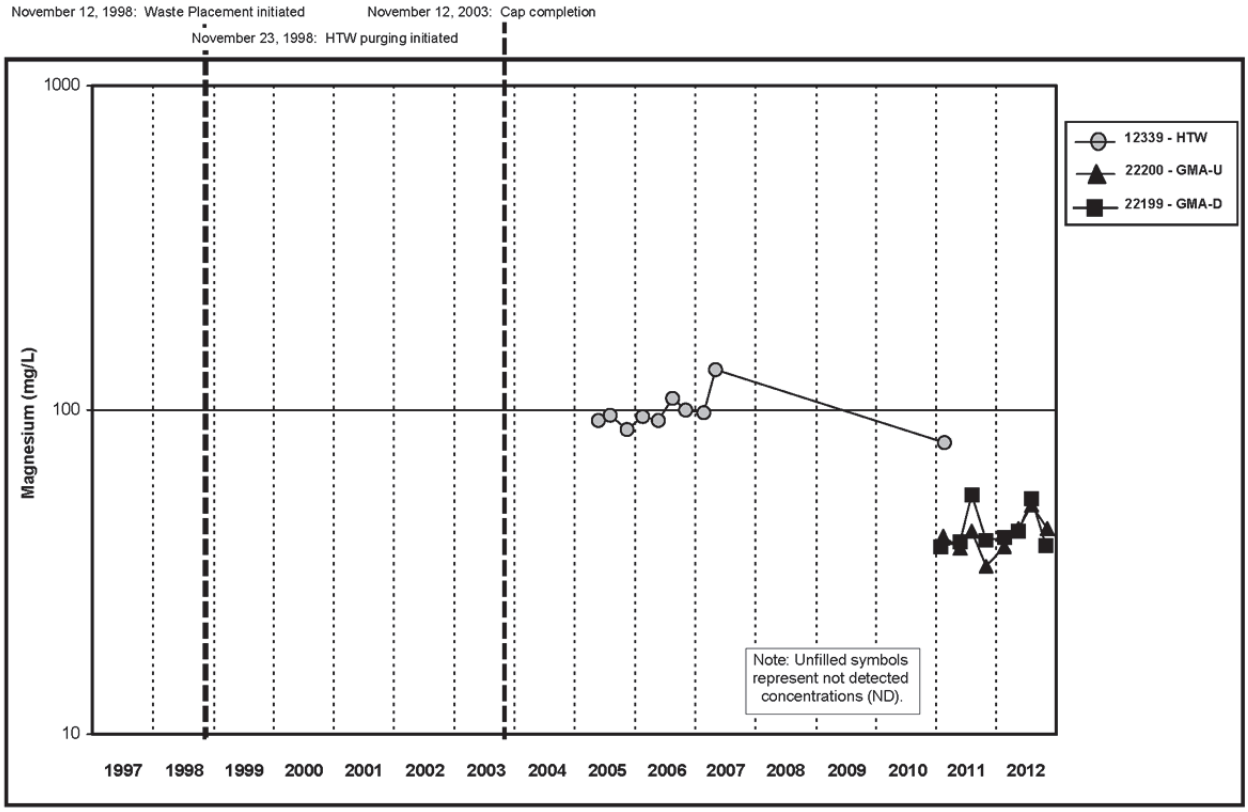


Figure A.5.2–8B. Cell 2 Magnesium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

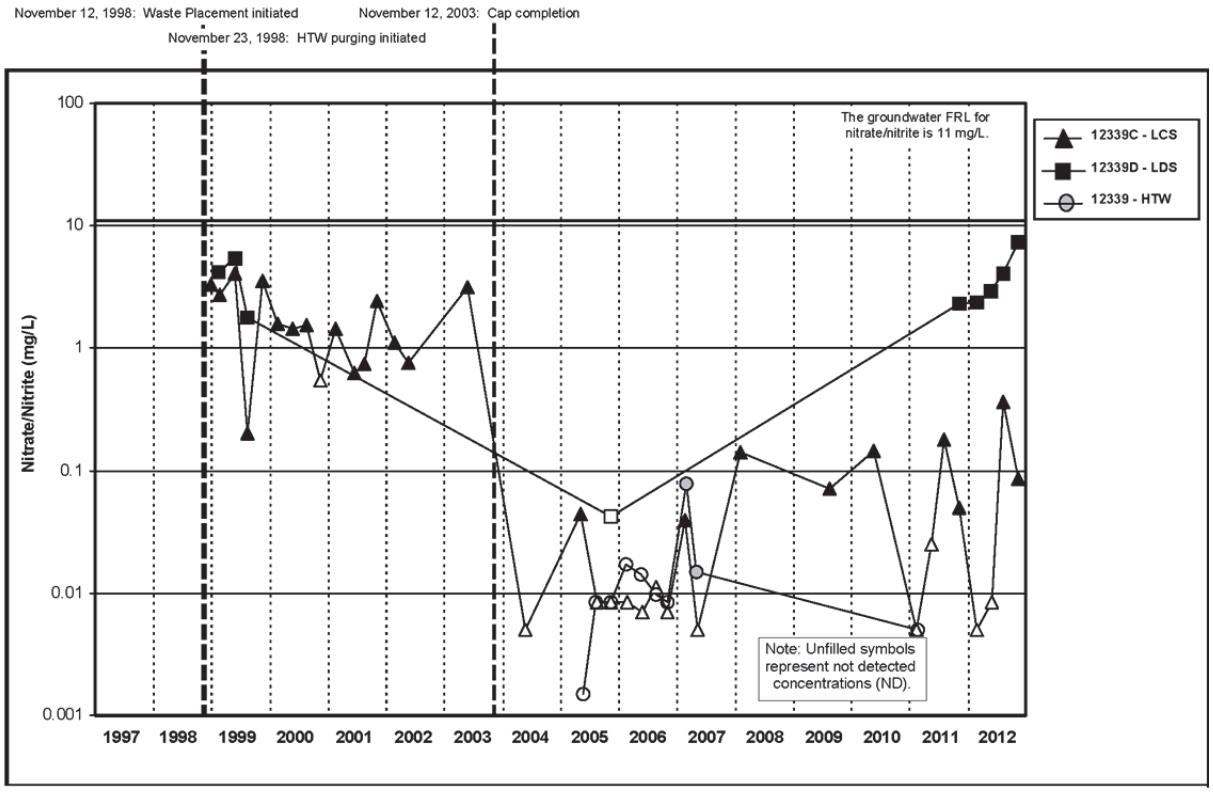


Figure A.5.2–9A. Cell 2 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for LCS, LDS, and HTW

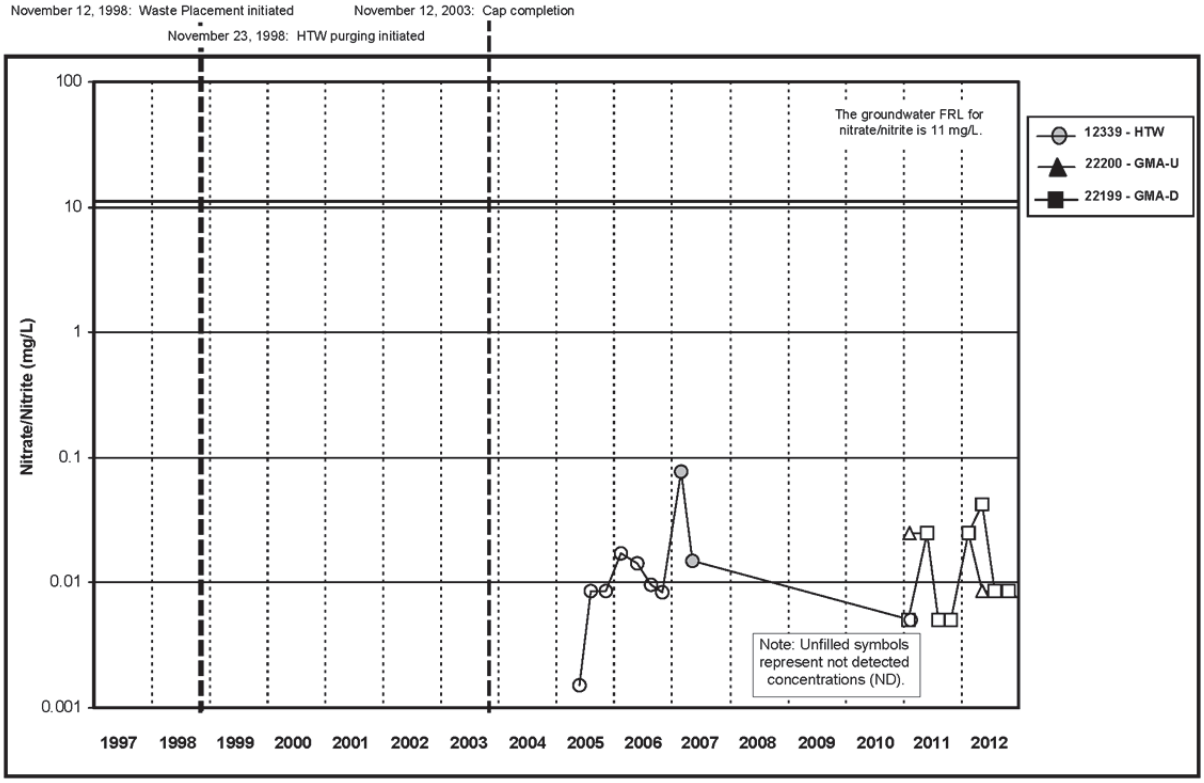


Figure A.5.2–9B. Cell 2 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

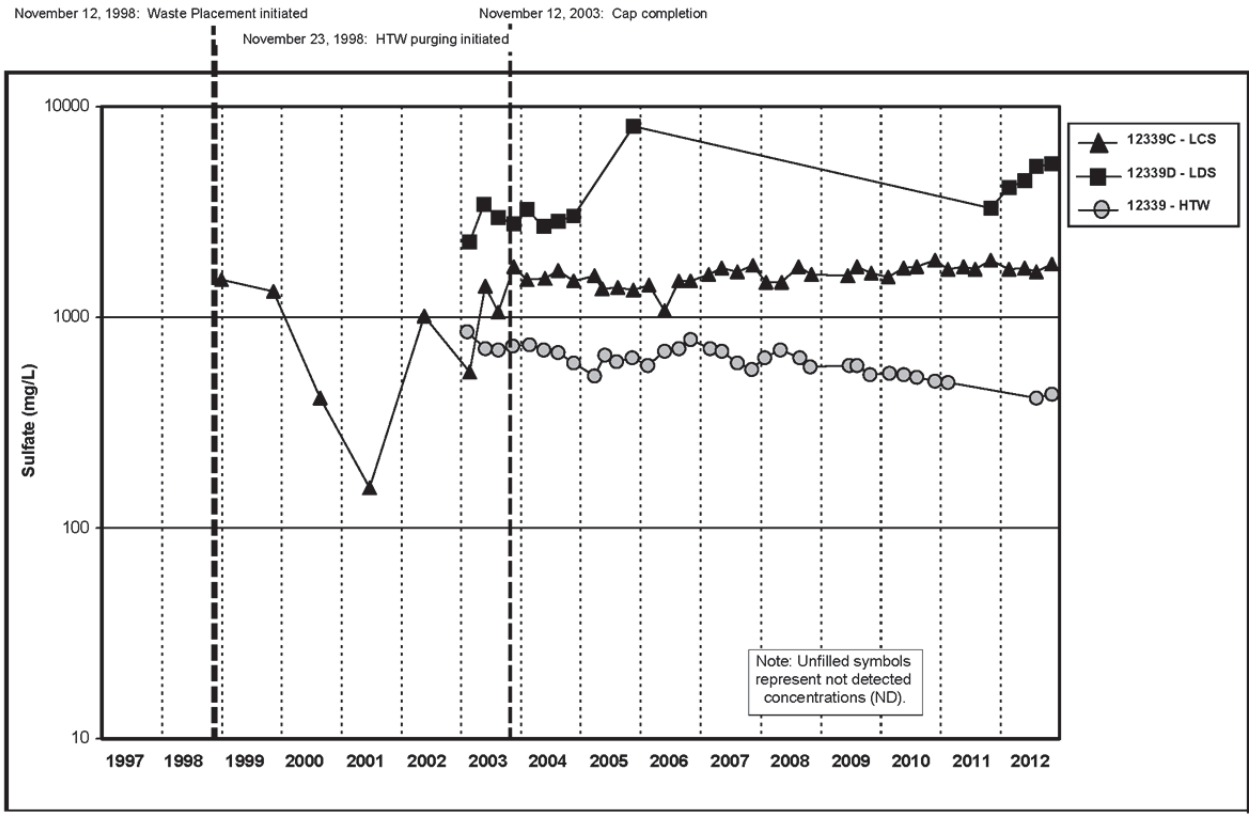


Figure A.5.2–10A. Cell 2 Sulfate Concentration vs. Time Plot for LCS, LDS, and HTW

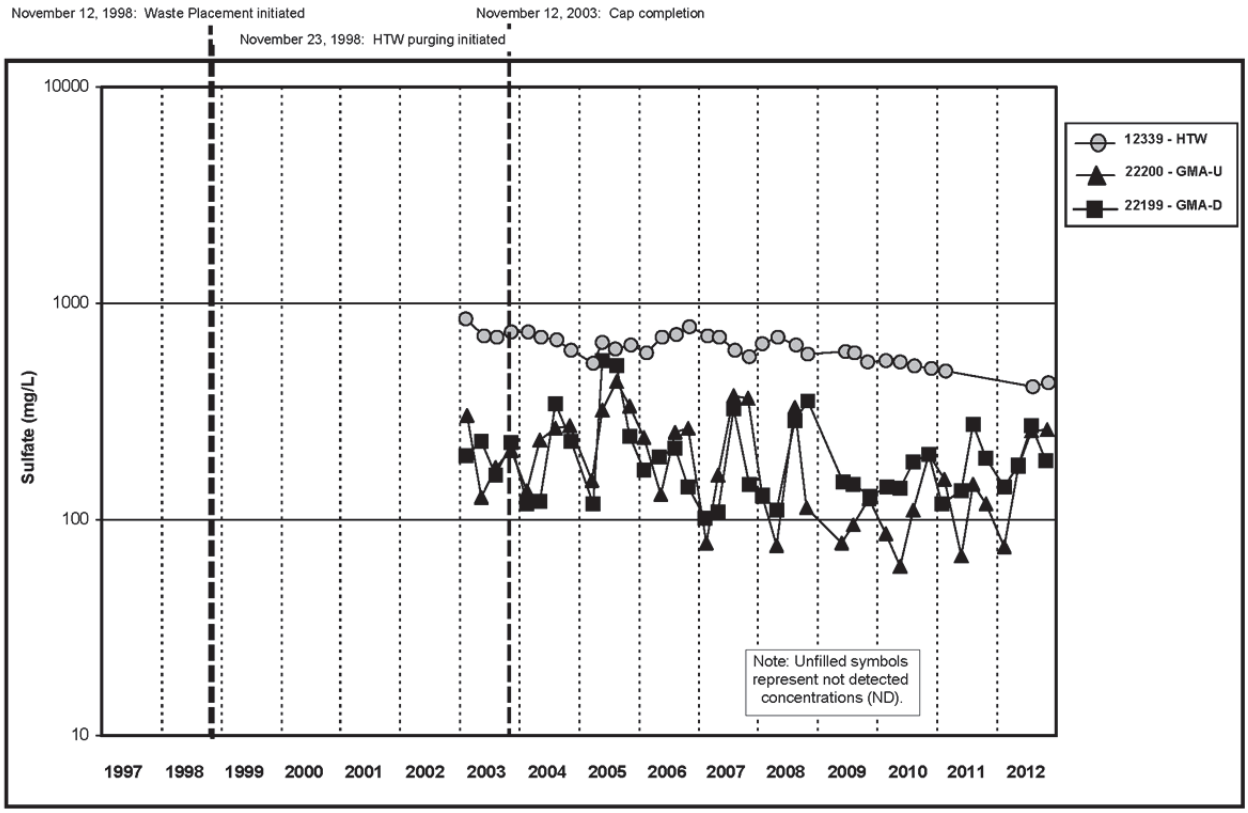


Figure A.5.2–10B. Cell 2 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

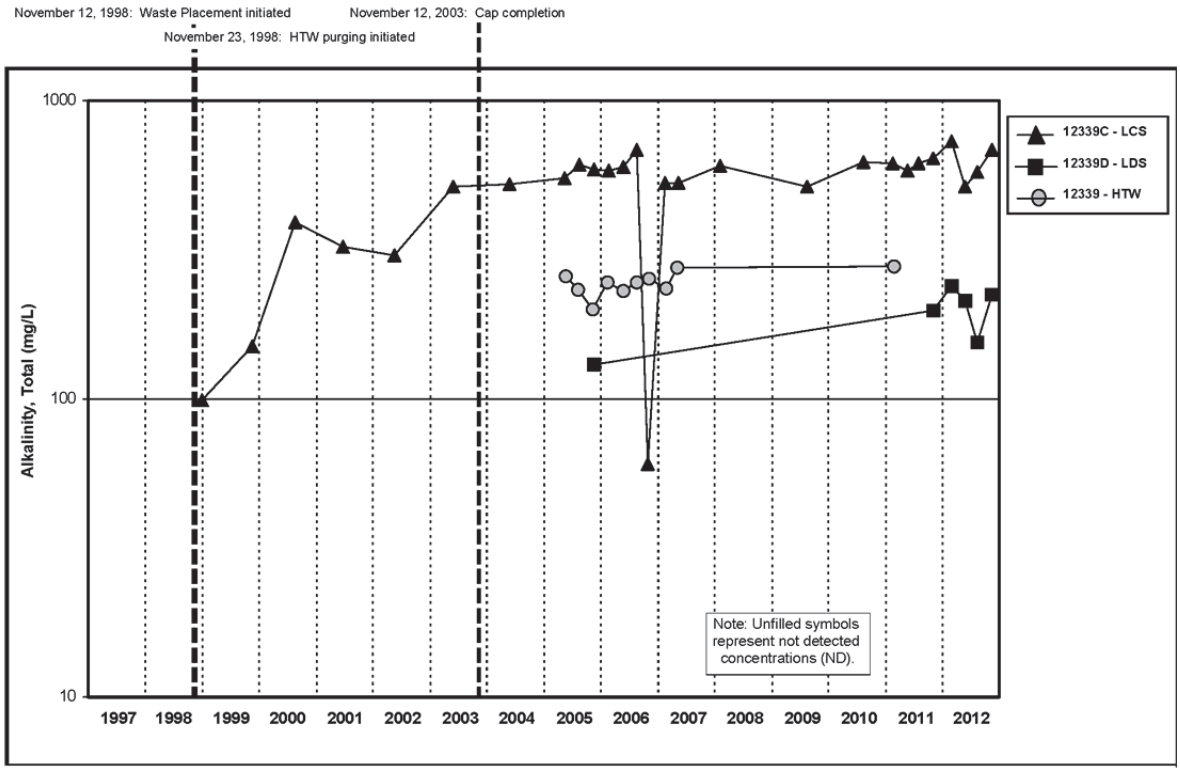


Figure A.5.2–11A. Cell 2 Alkalinity, Total (As $CaCO_3$) Concentration vs. Time Plot for LCS, LDS, and HTW

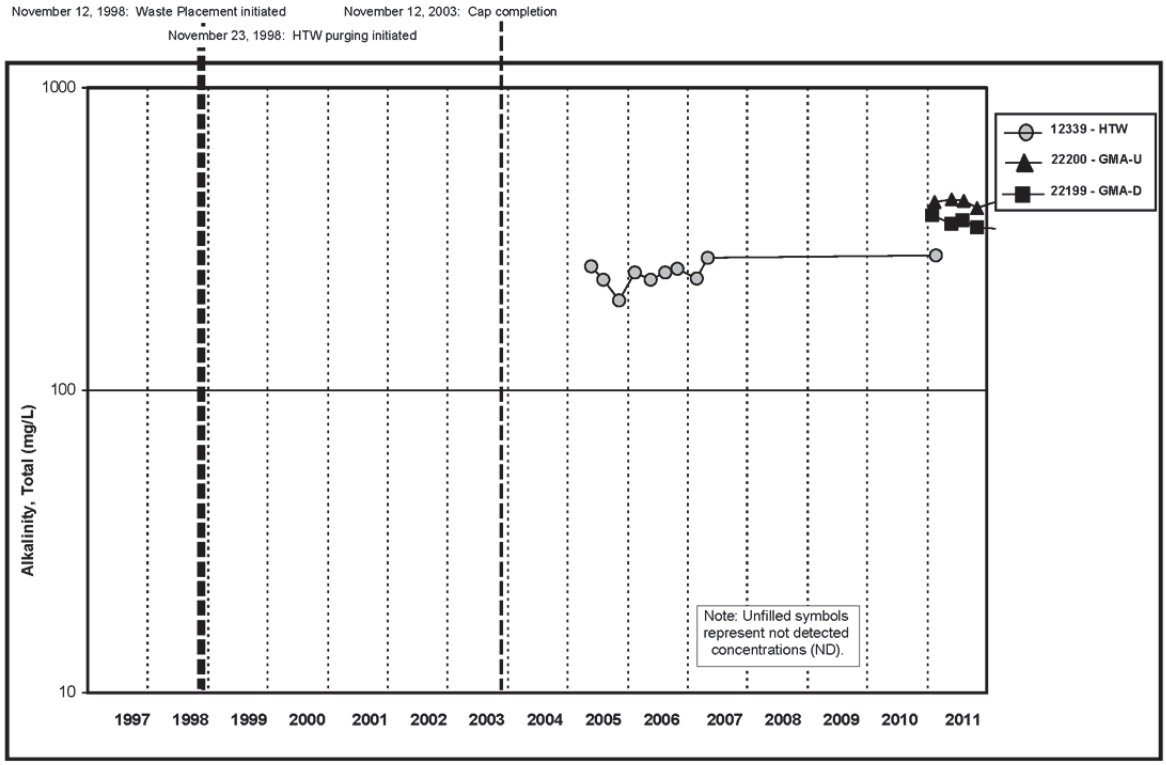


Figure A.5.2–11B. Cell 2 Alkalinity, Total (As $CaCO_3$) Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

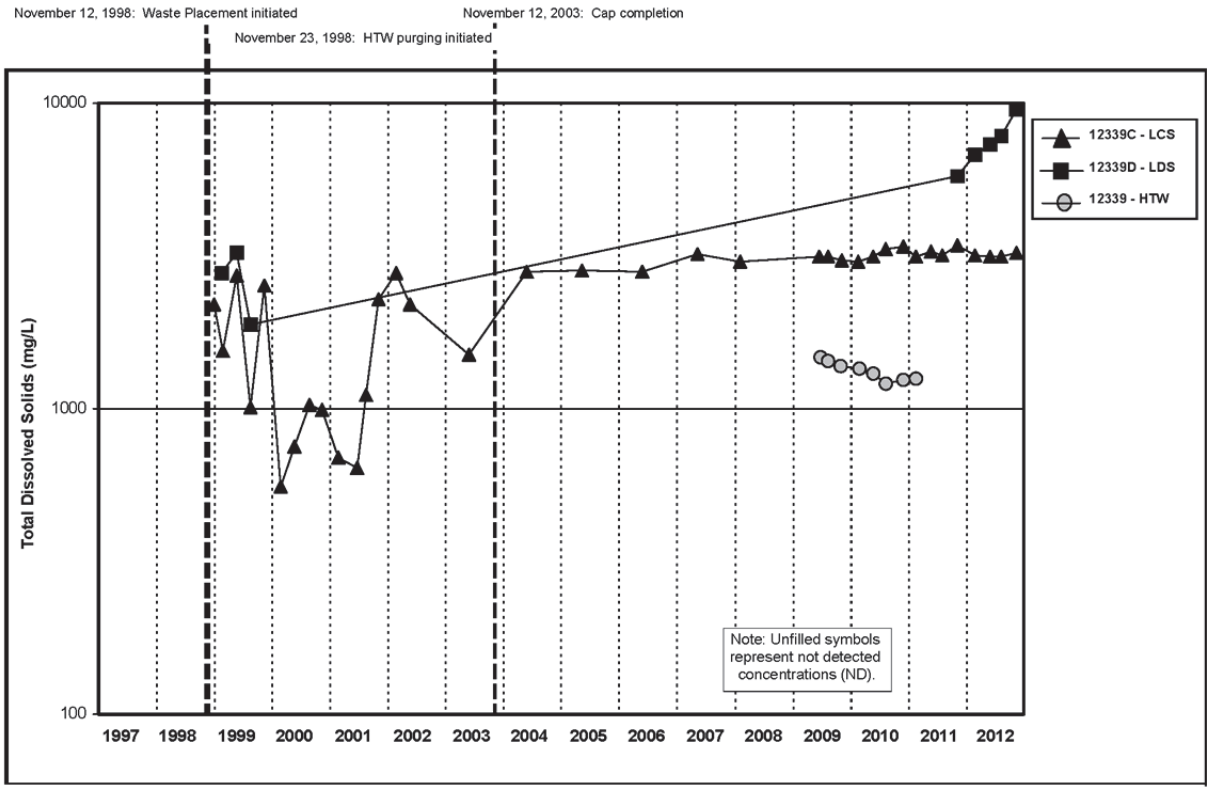


Figure A.5.2–12A. Cell 2 Total Dissolved Solids Concentration vs. Time Plot for LCS, LDS, and HTW

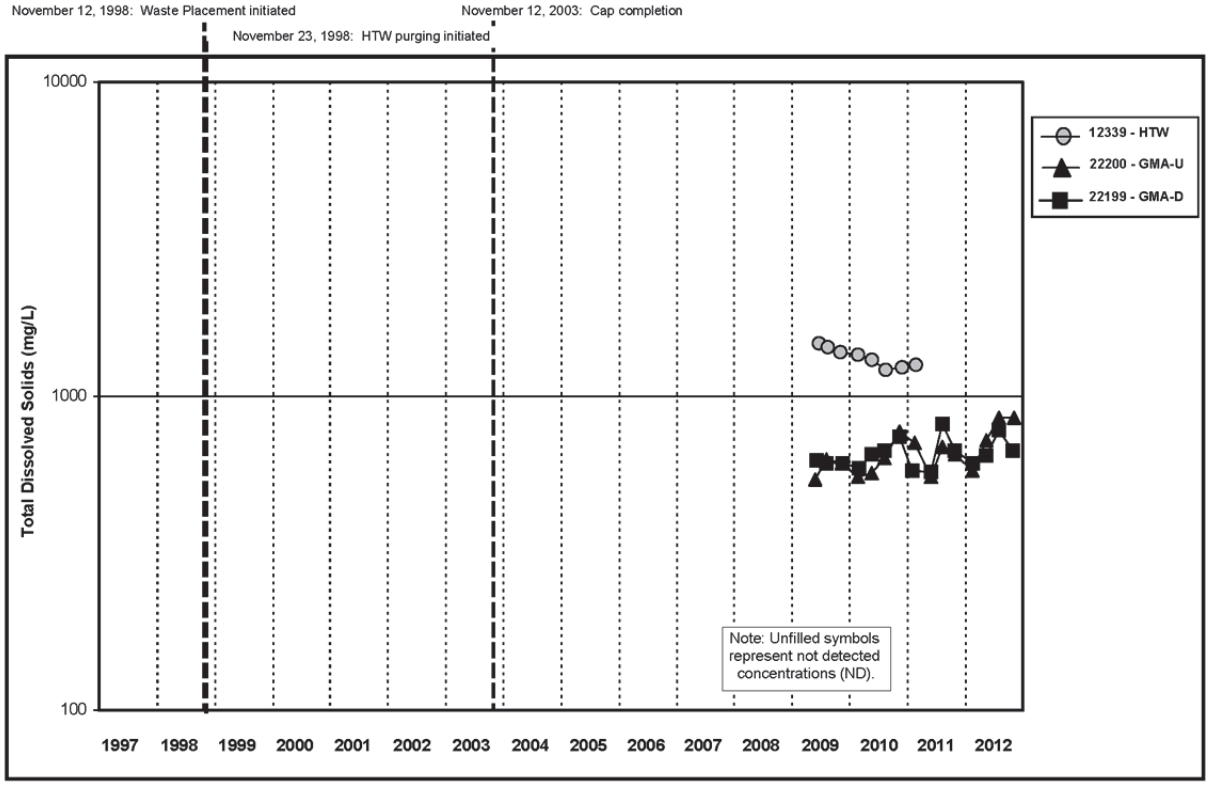


Figure A.5.2–12B. Cell 2 Total Dissolved Solids Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

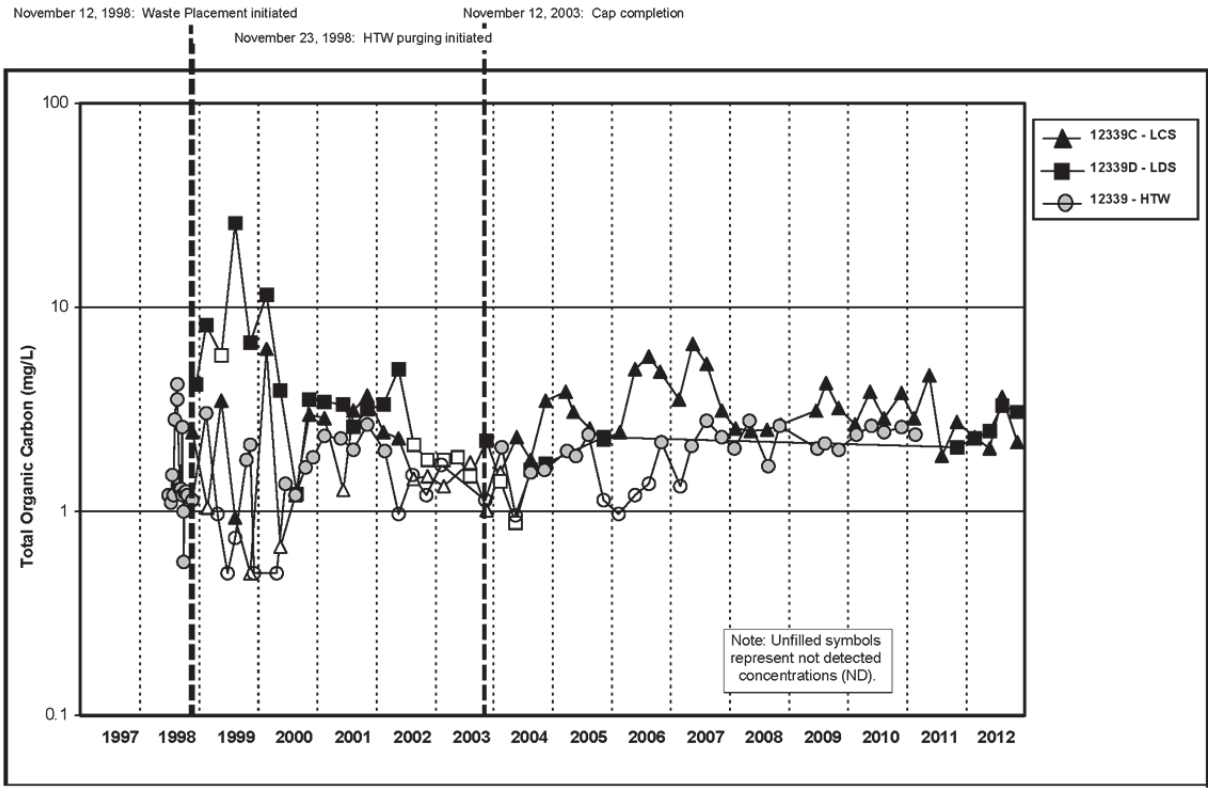


Figure A.5.2–13A. Cell 2 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, and HTW

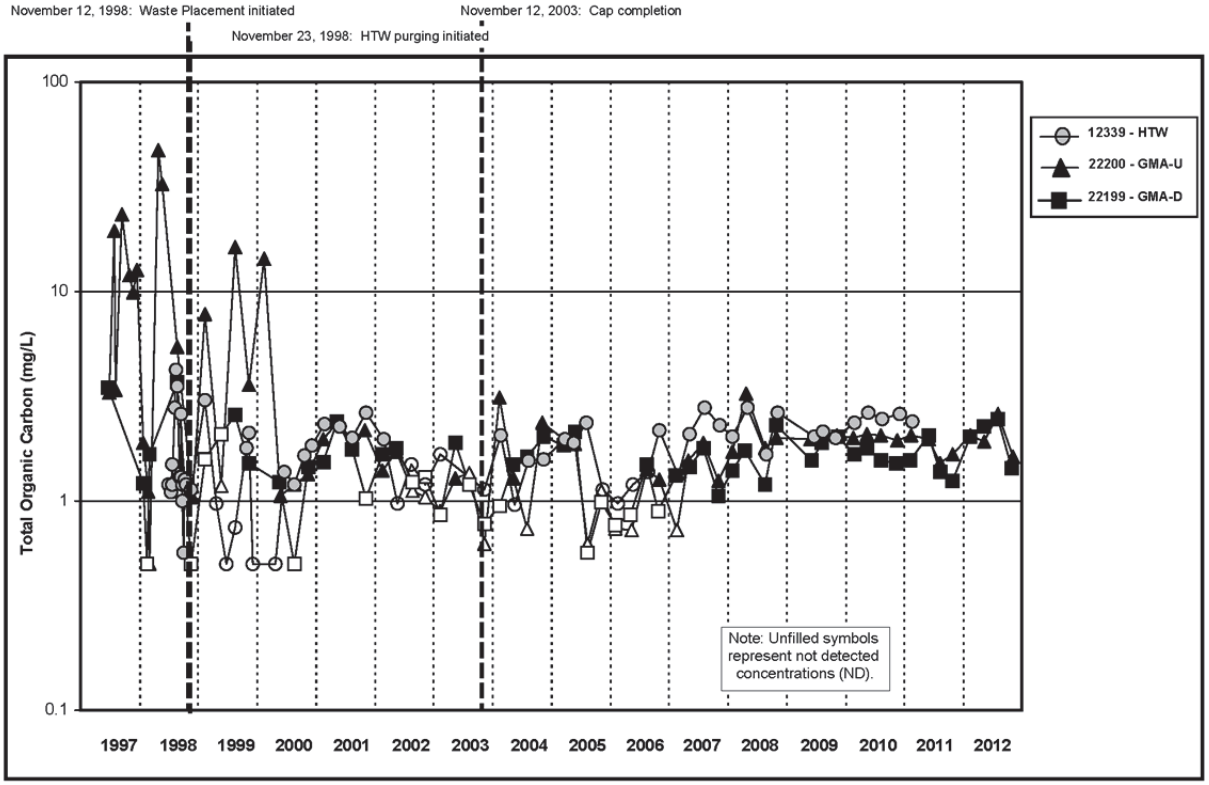


Figure A.5.2–13B. Cell 2 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

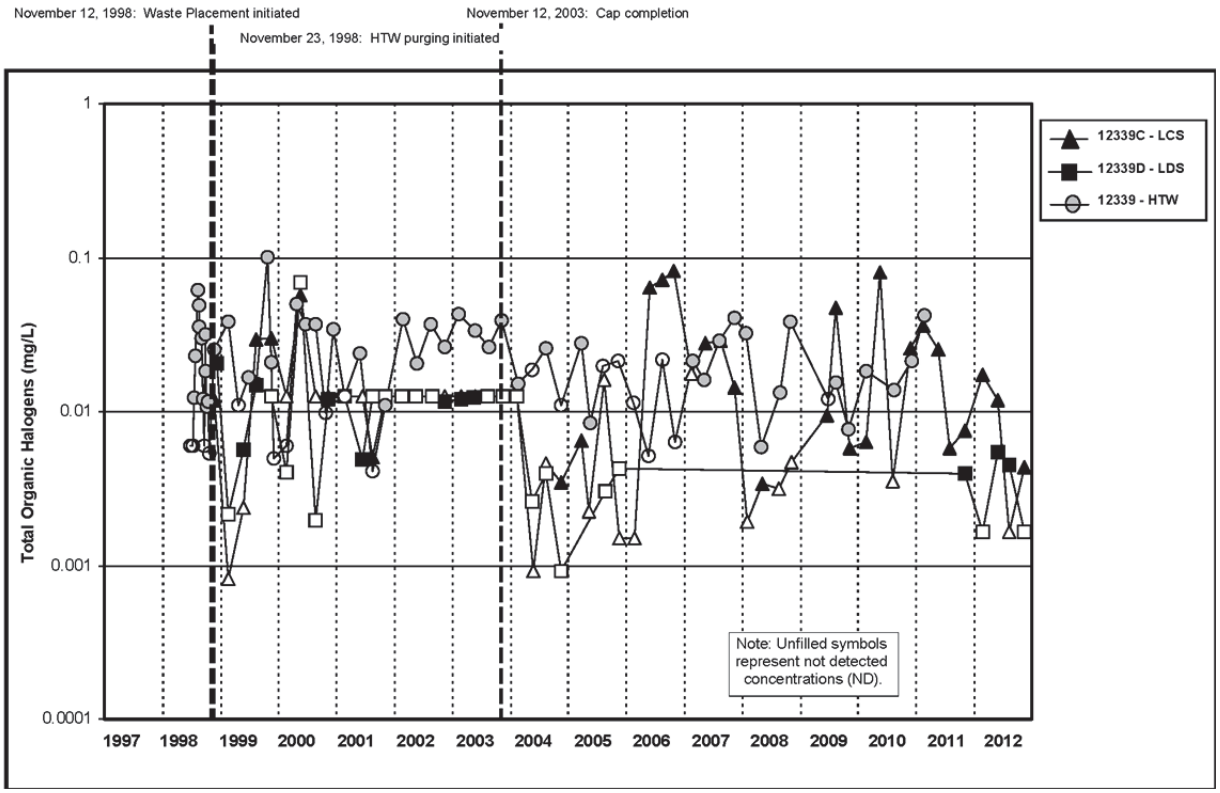


Figure A.5.2–14A. Cell 2 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, and HTW

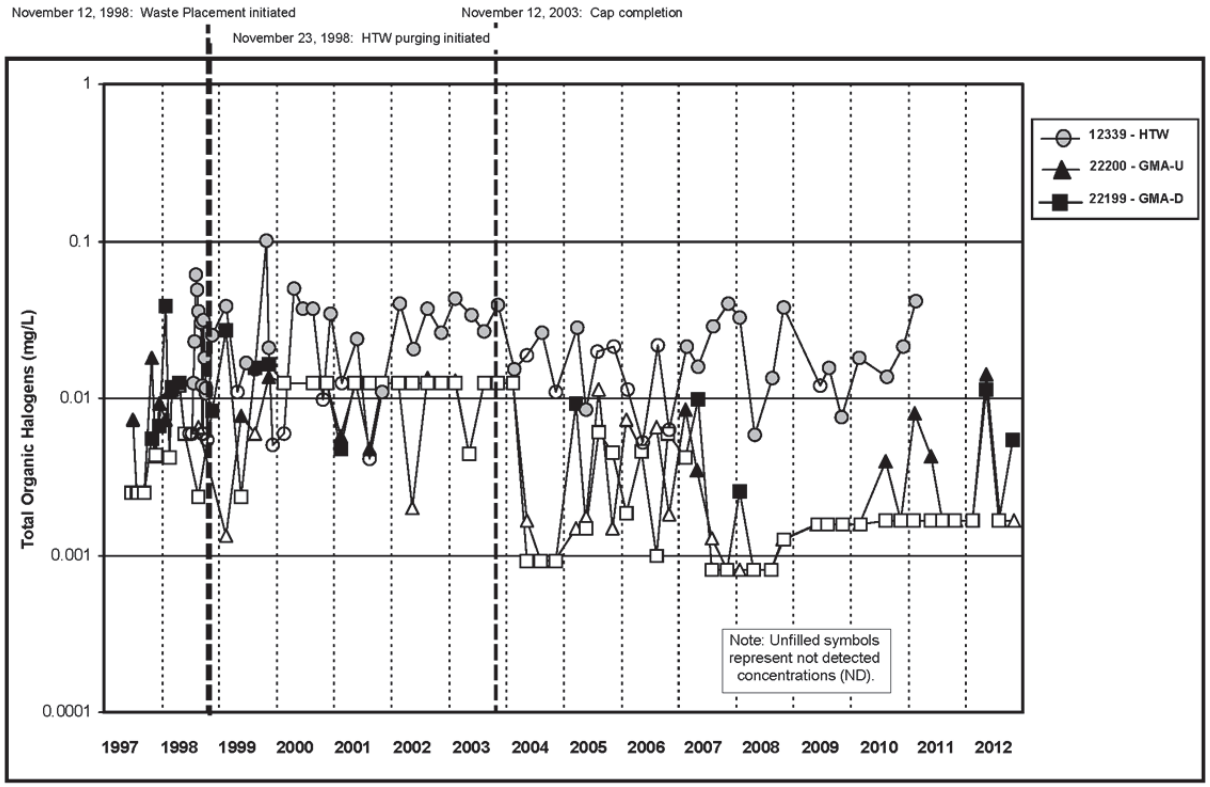


Figure A.5.2–14B. Cell 2 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

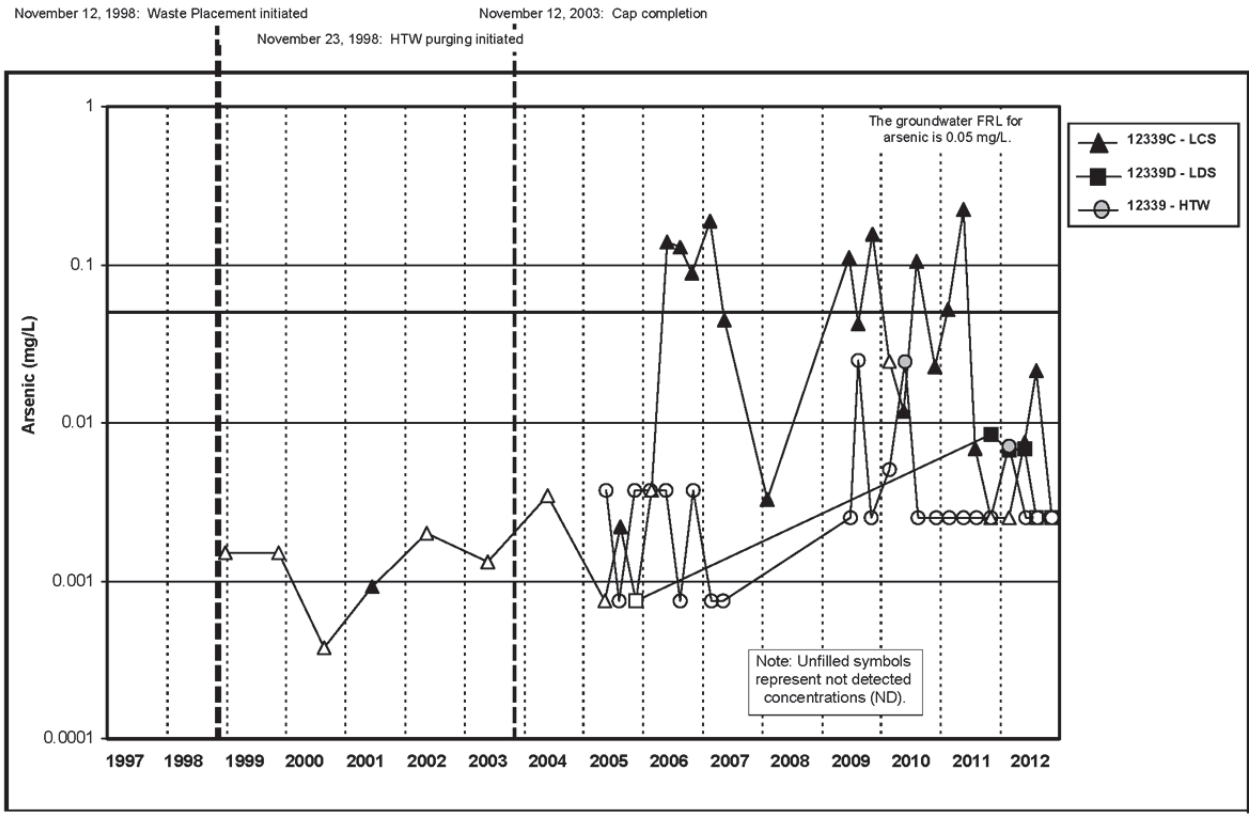


Figure A.5.2–15A. Cell 2 Arsenic Concentration vs. Time Plot for LCS, LDS, and HTW

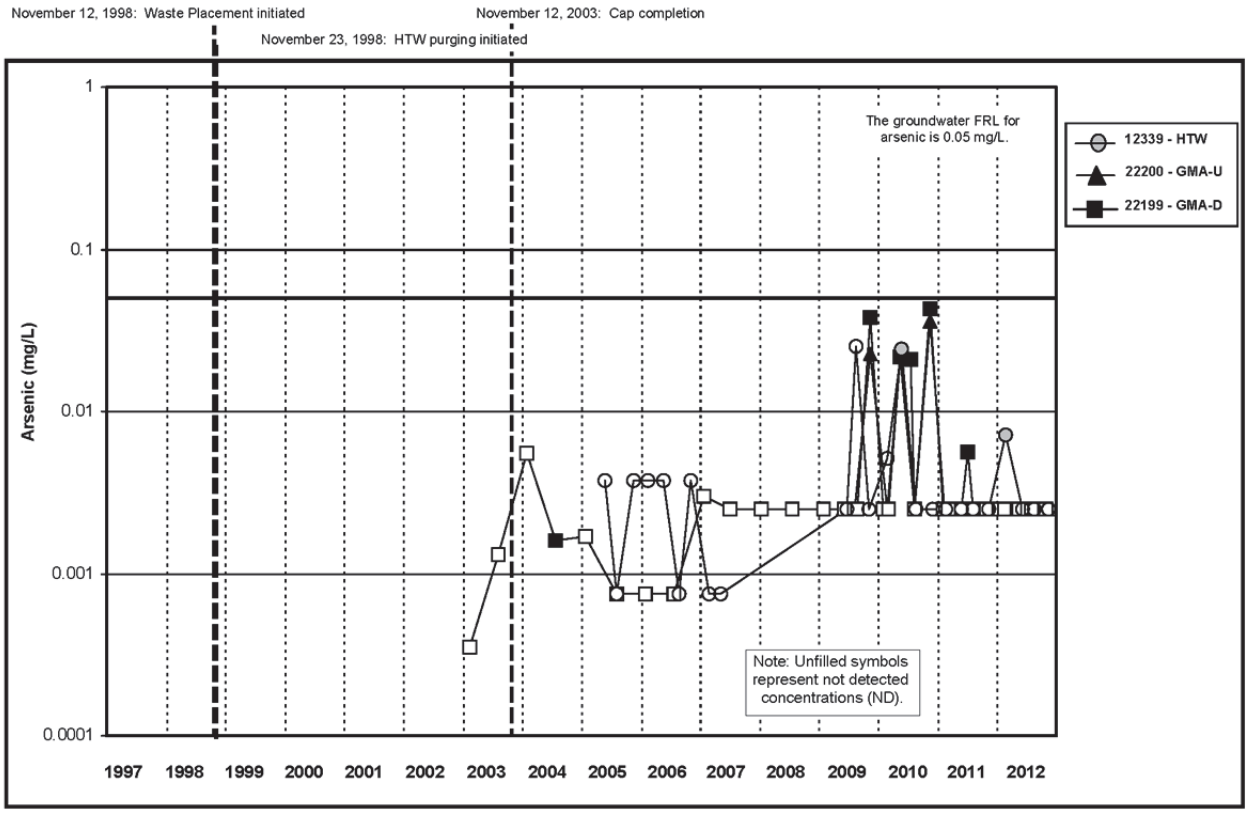


Figure A.5.2–15B. Cell 2 Arsenic Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

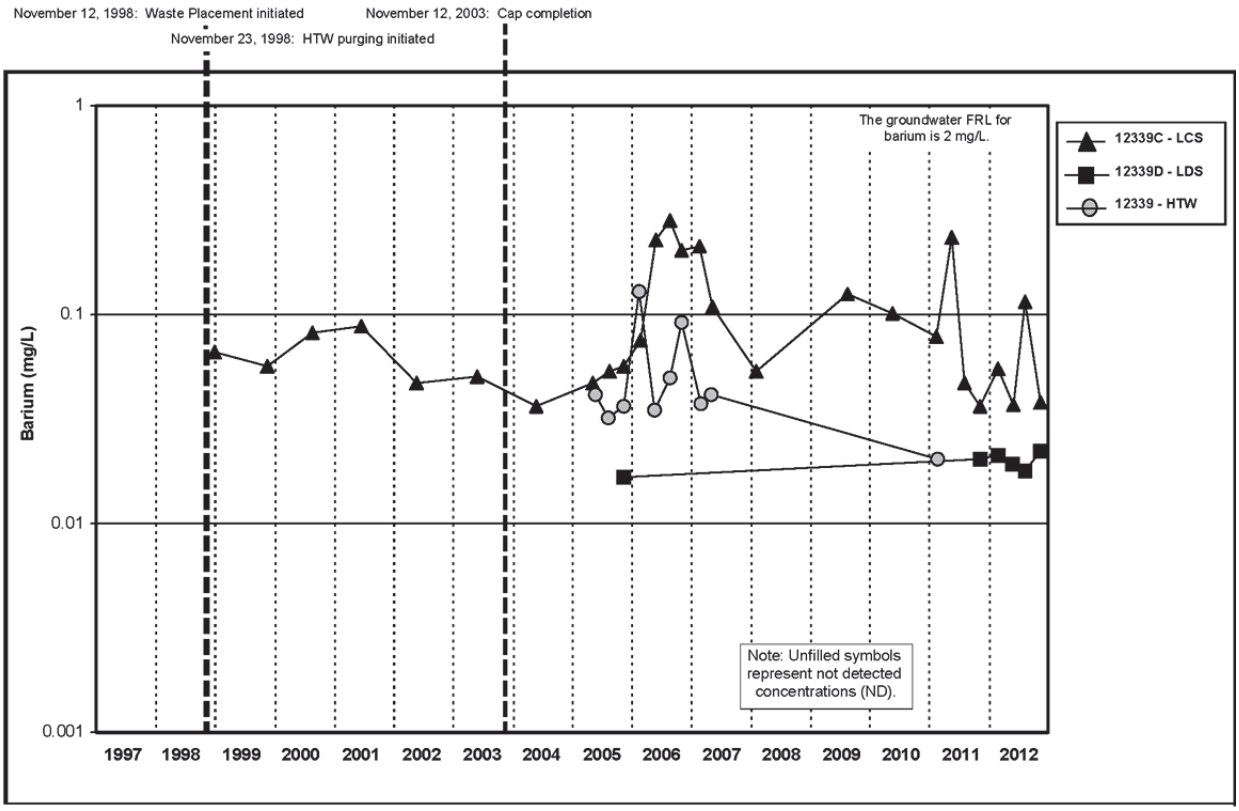


Figure A.5.2–16A. Cell 2 Barium Concentration vs. Time Plot for LCS, LDS, and HTW

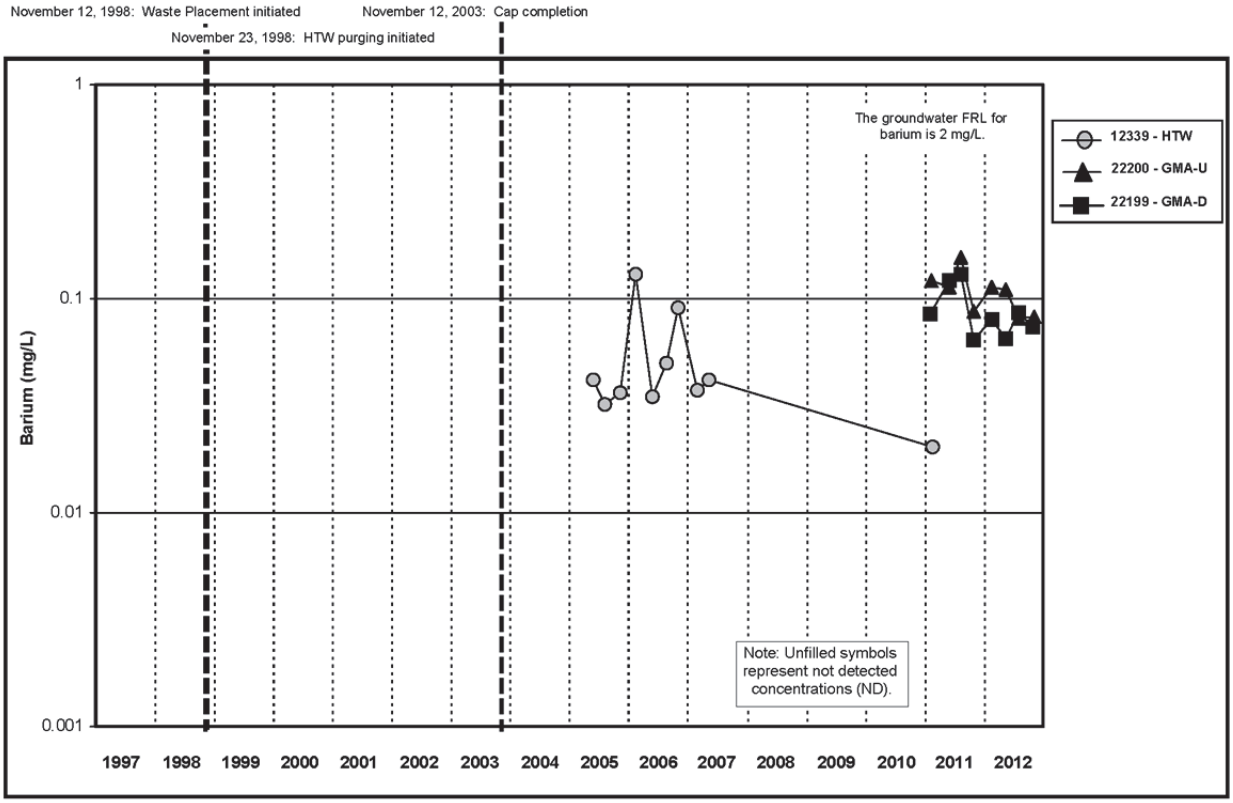


Figure A.5.2–16B. Cell 2 Barium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

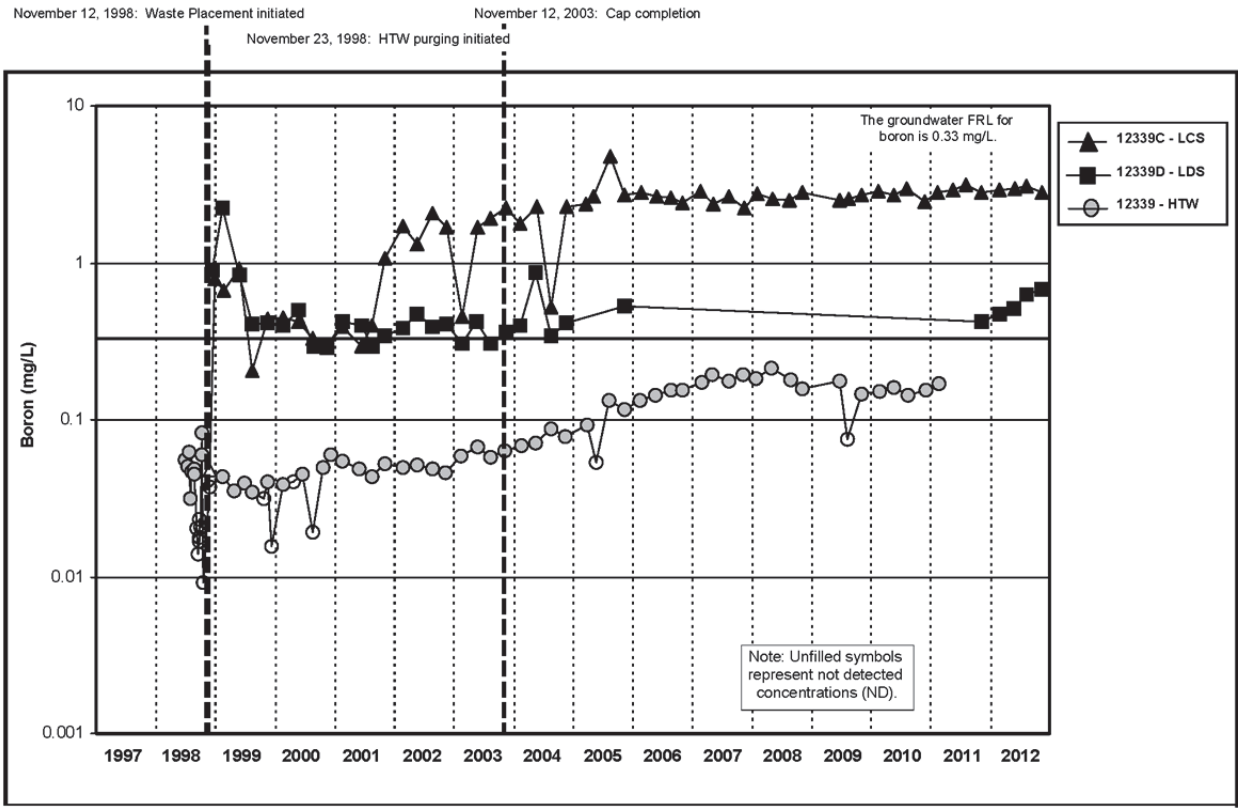


Figure A.5.2–17A. Cell 2 Boron Concentration vs. Time Plot for LCS, LDS, and HTW

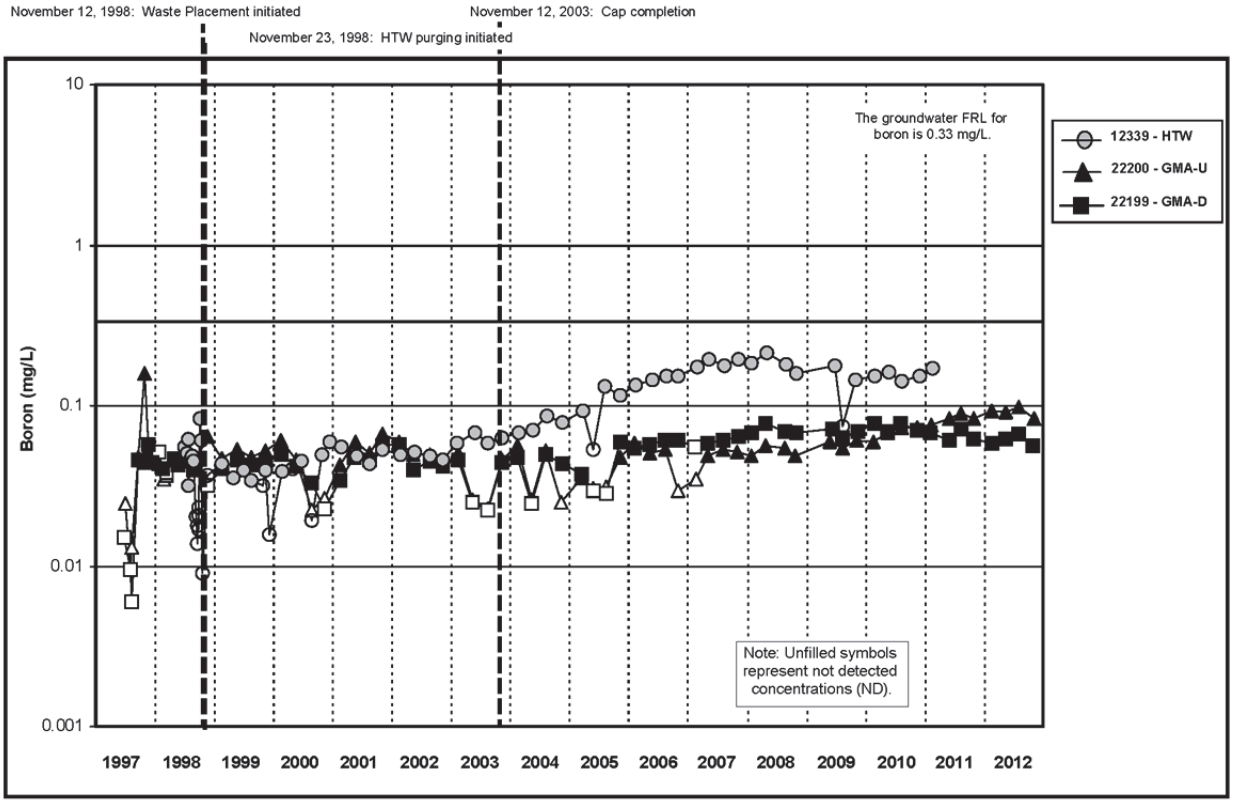


Figure A.5.2–17B. Cell 2 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

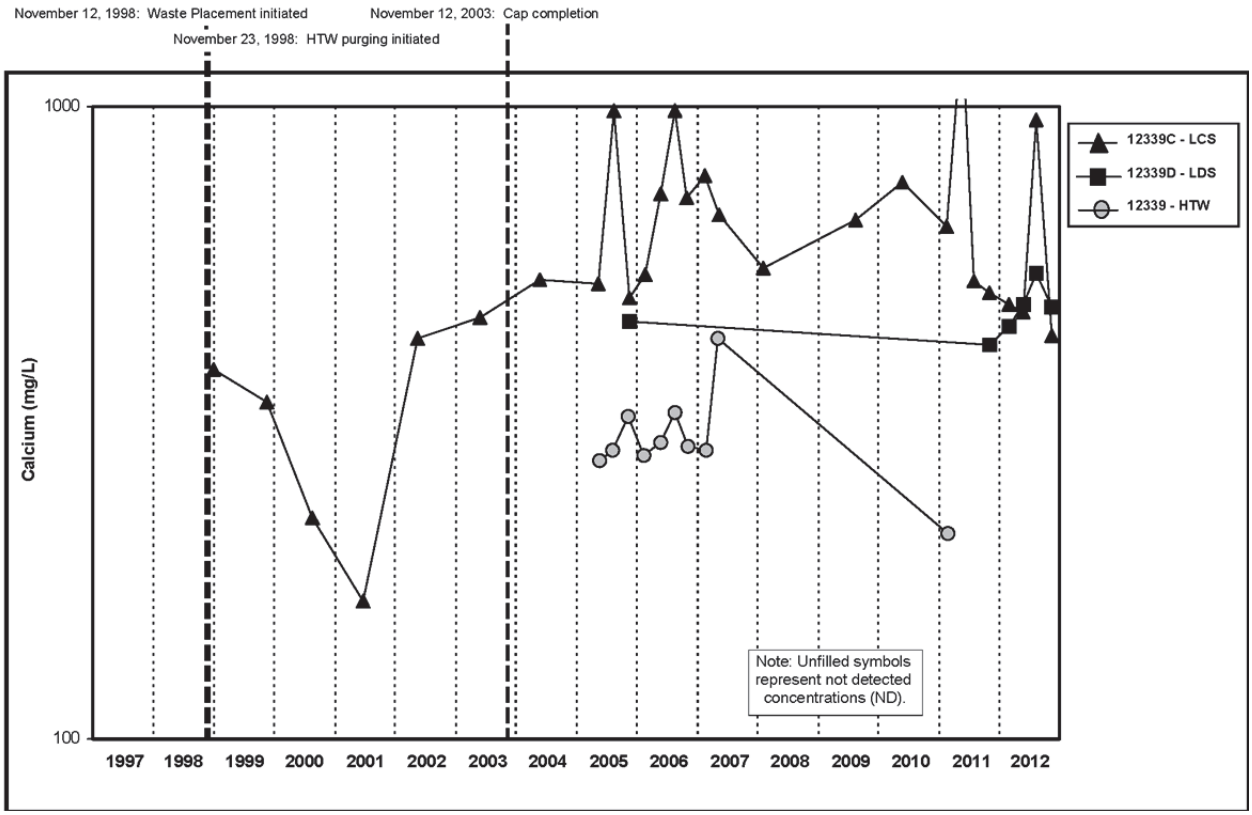


Figure A.5.2–18A. Cell 2 Calcium Concentration vs. Time Plot for LCS, LDS, and HTW

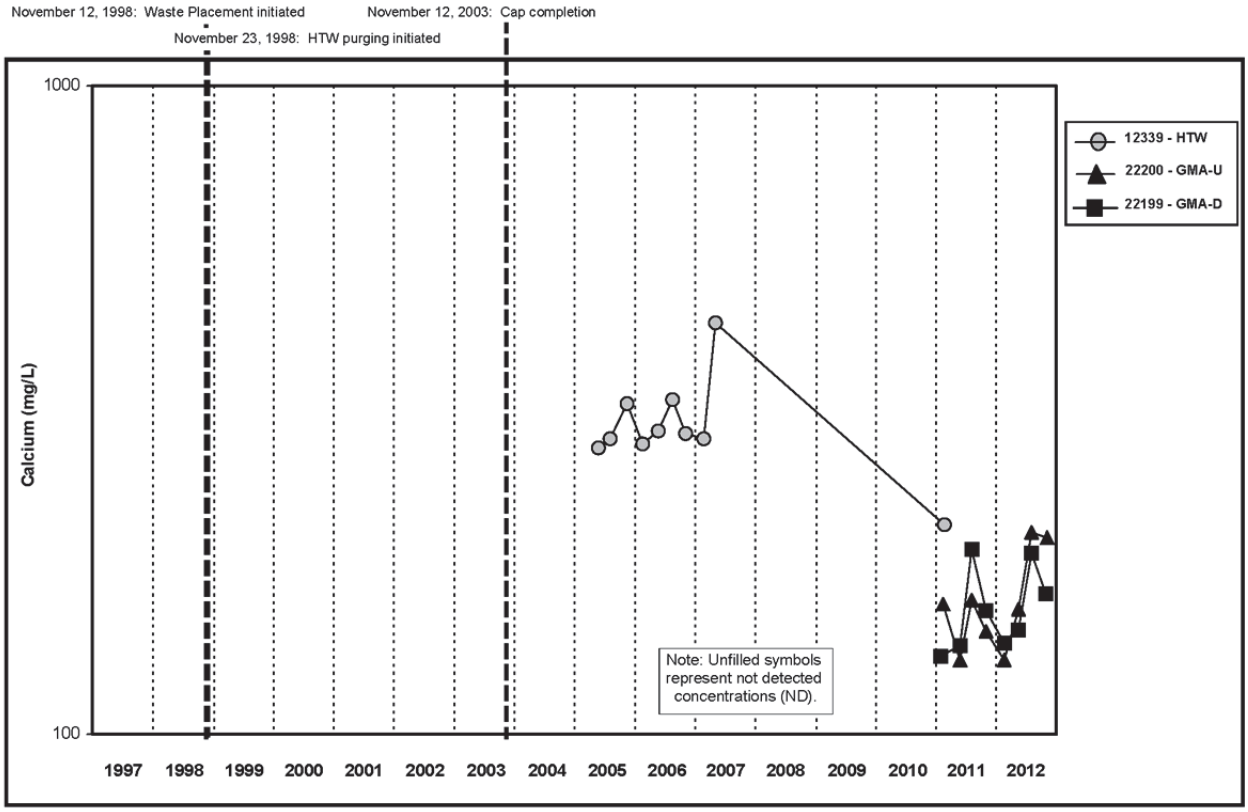


Figure A.5.2–18B. Cell 2 Calcium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

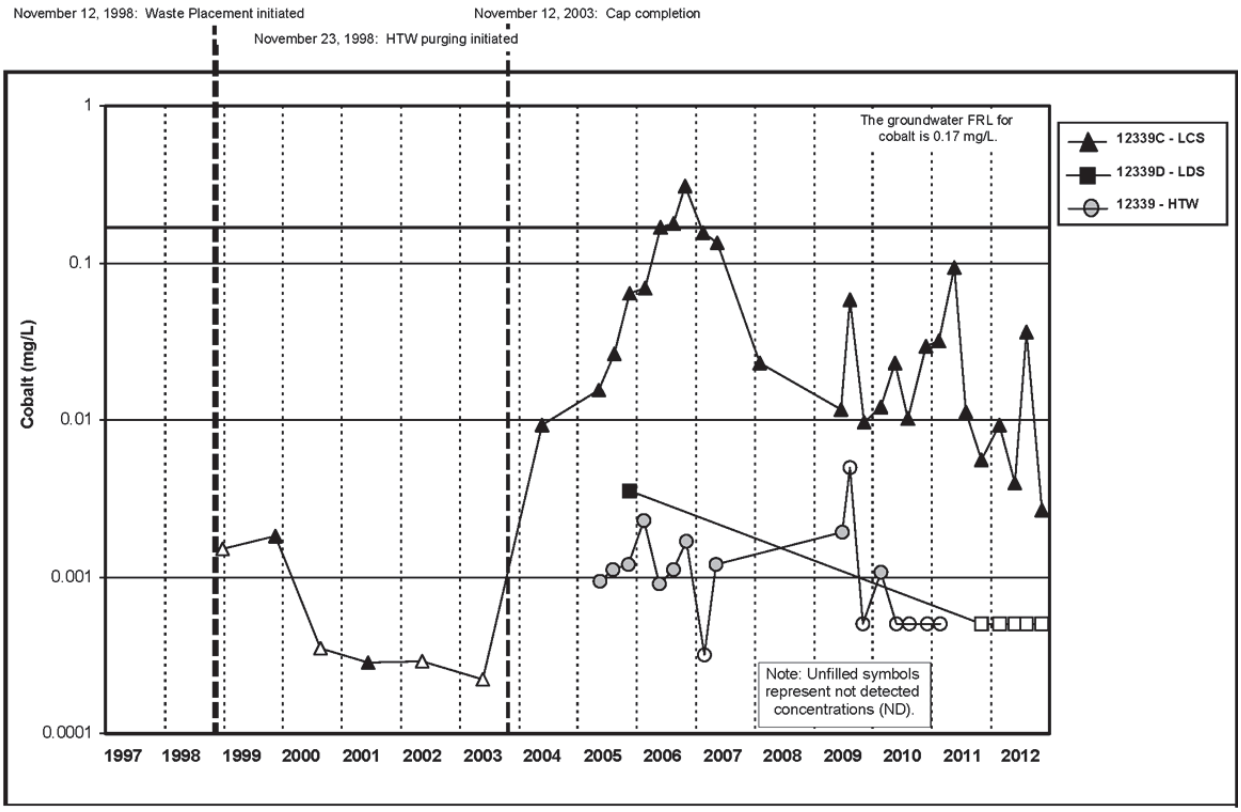


Figure A.5.2–19A. Cell 2 Cobalt Concentration vs. Time Plot for LCS, LDS, and HTW

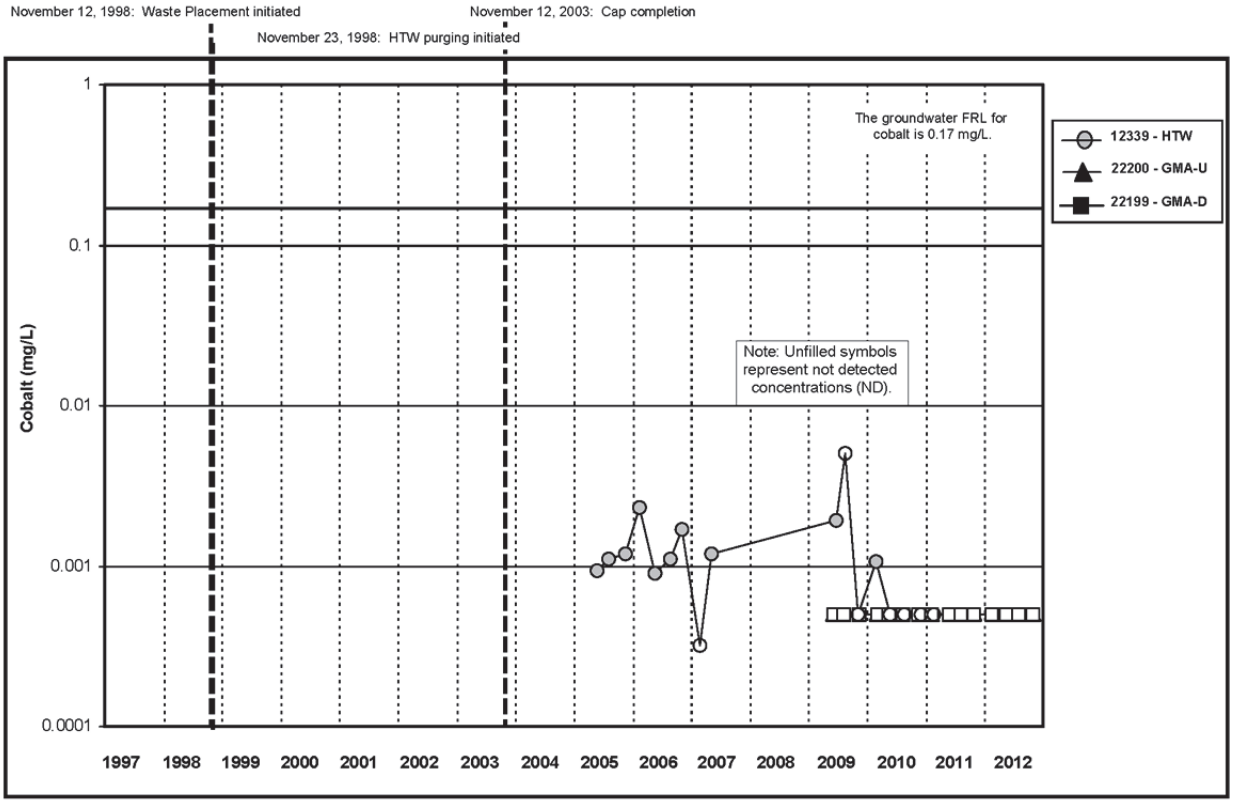


Figure A.5.2–19B. Cell 2 Cobalt Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

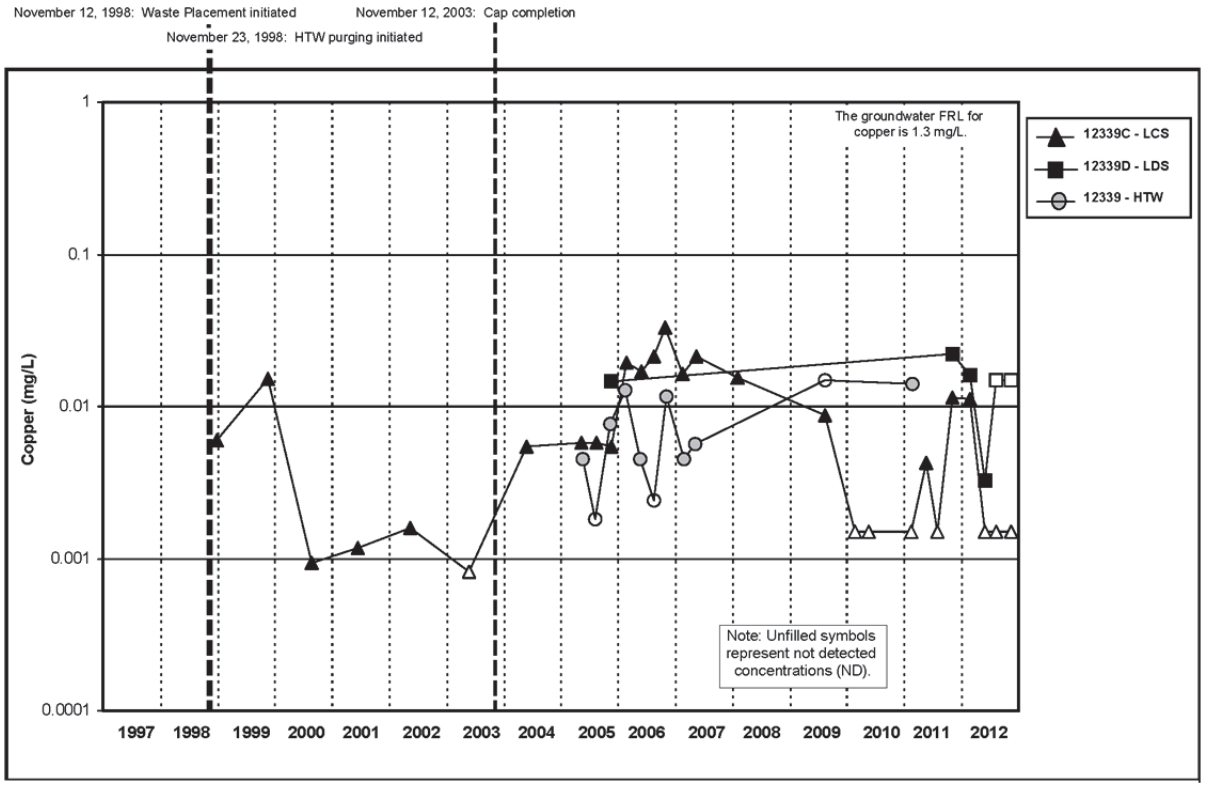


Figure A.5.2–20A. Cell 2 Copper Concentration vs. Time Plot for LCS, LDS, and HTW

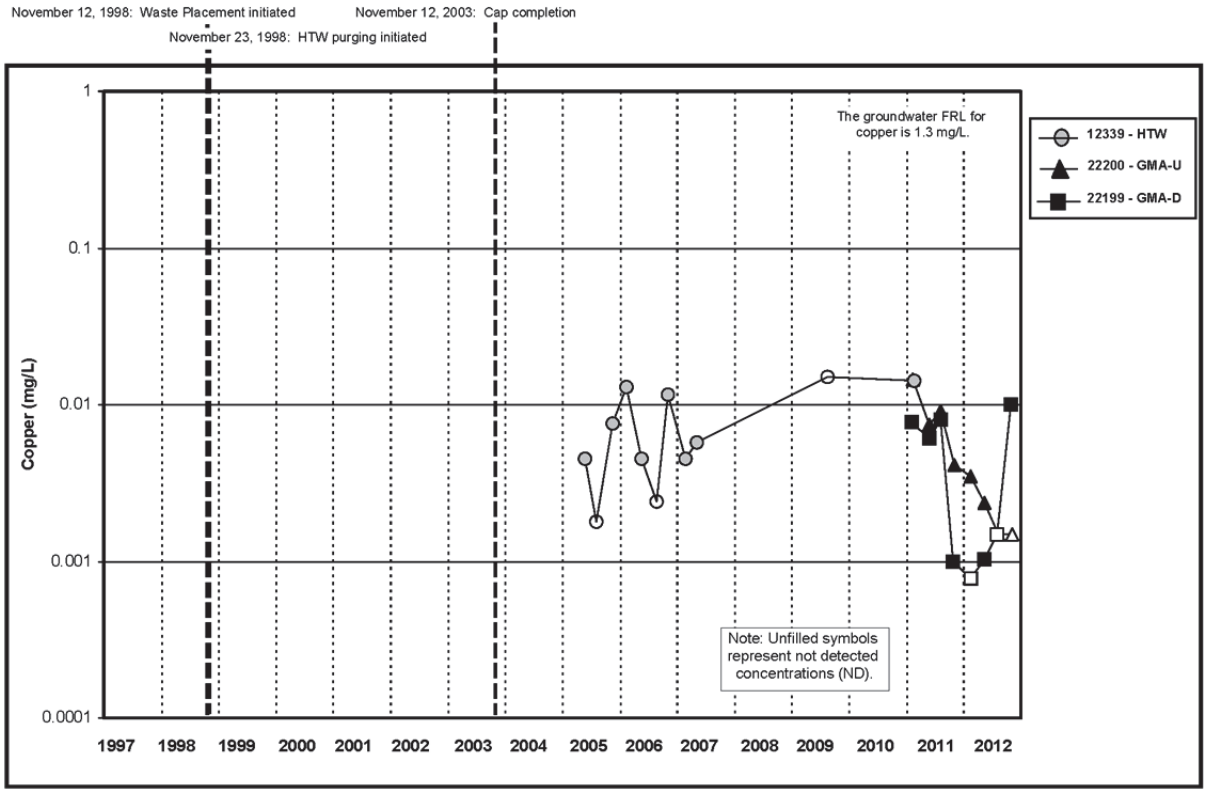


Figure A.5.2–20B. Cell 2 Copper Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

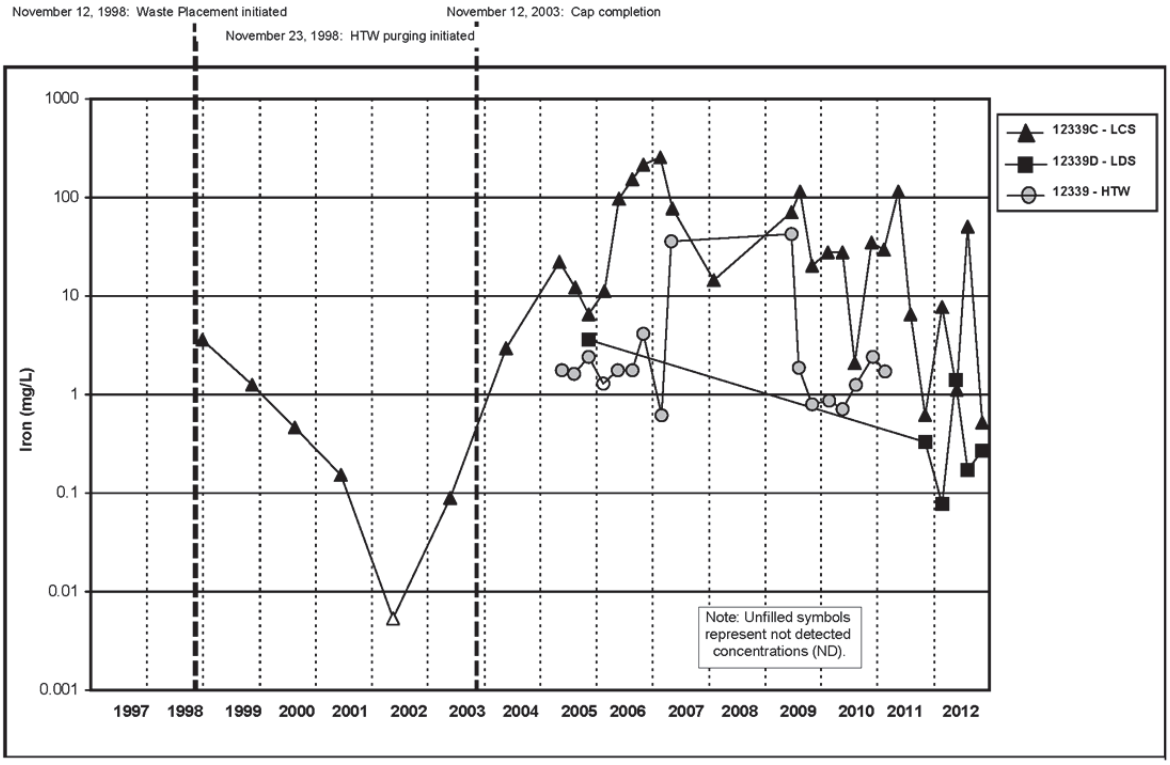


Figure A.5.2–21A. Cell 2 Iron Concentration vs. Time Plot for LCS, LDS, and HTW

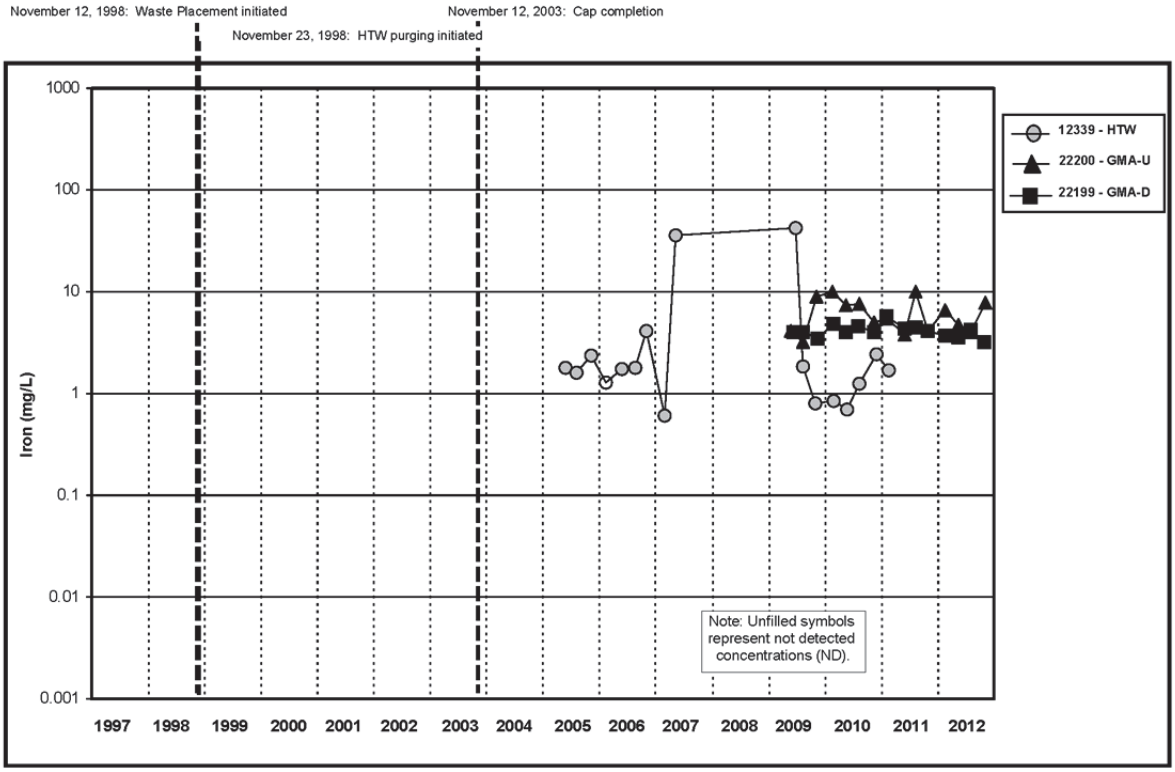


Figure A.5.2–21B. Cell 2 Iron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

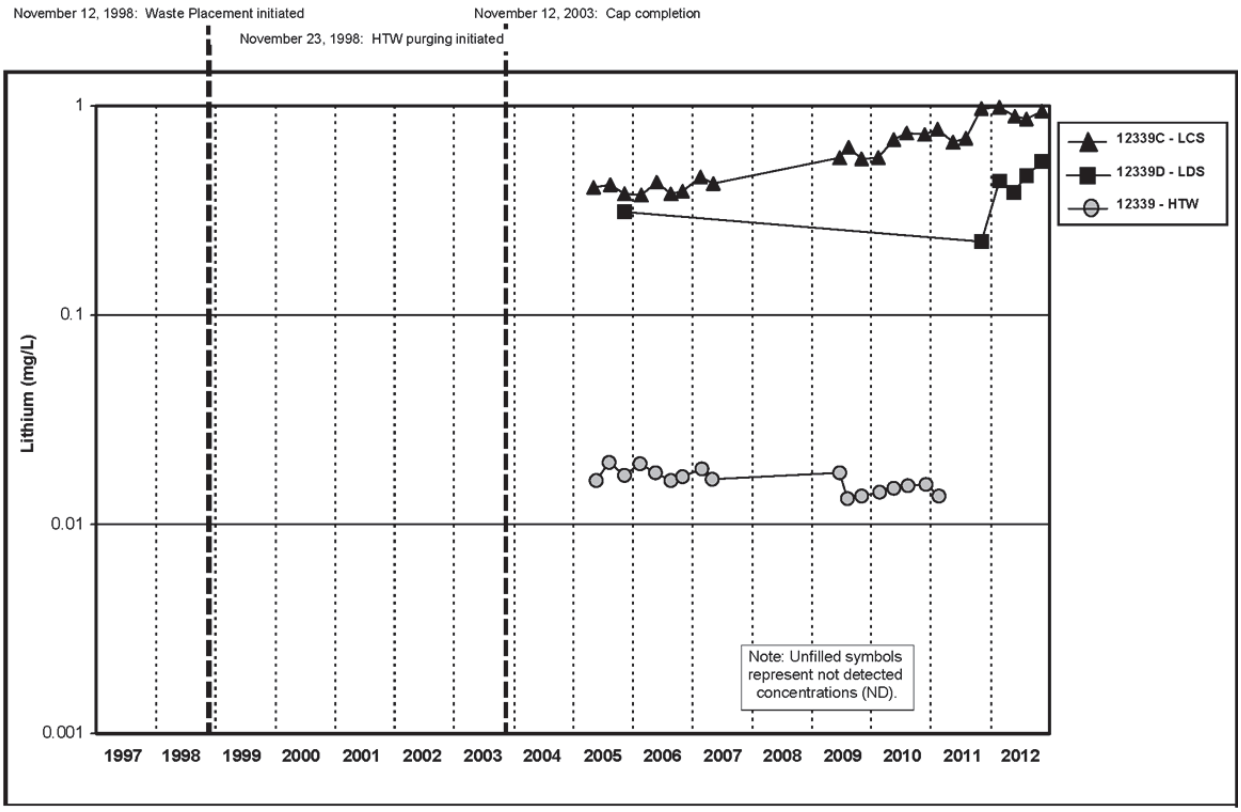


Figure A.5.2–22A. Cell 2 Lithium Concentration vs. Time Plot for LCS, LDS, and HTW

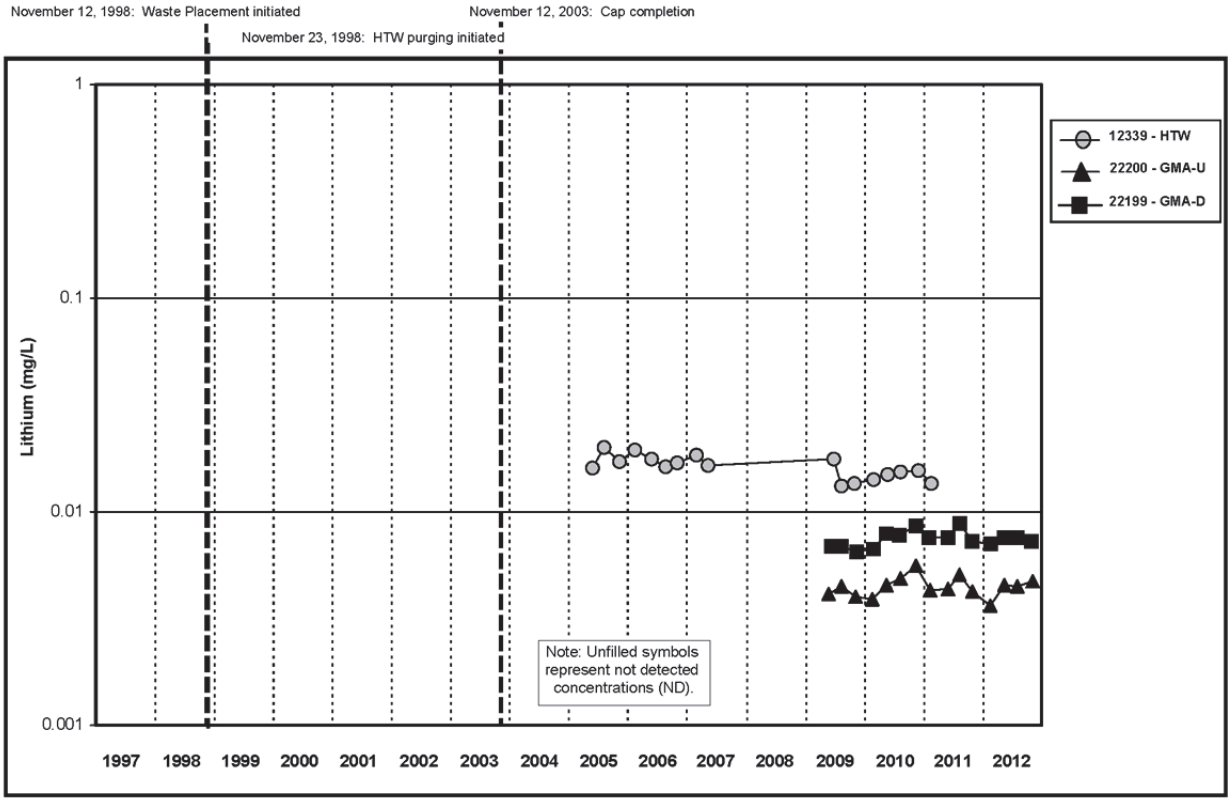


Figure A.5.2–22B. Cell 2 Lithium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

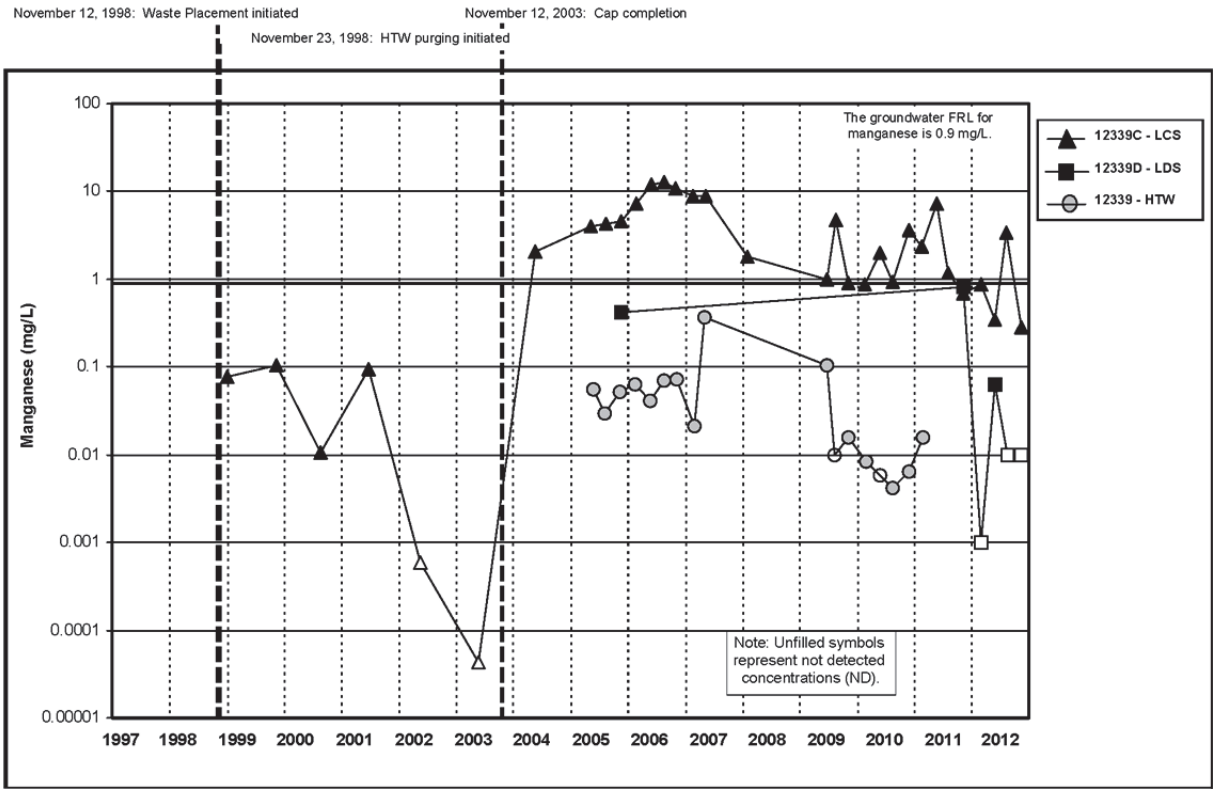


Figure A.5.2–23A. Cell 2 Manganese Concentration vs. Time Plot for LCS, LDS, and HTW

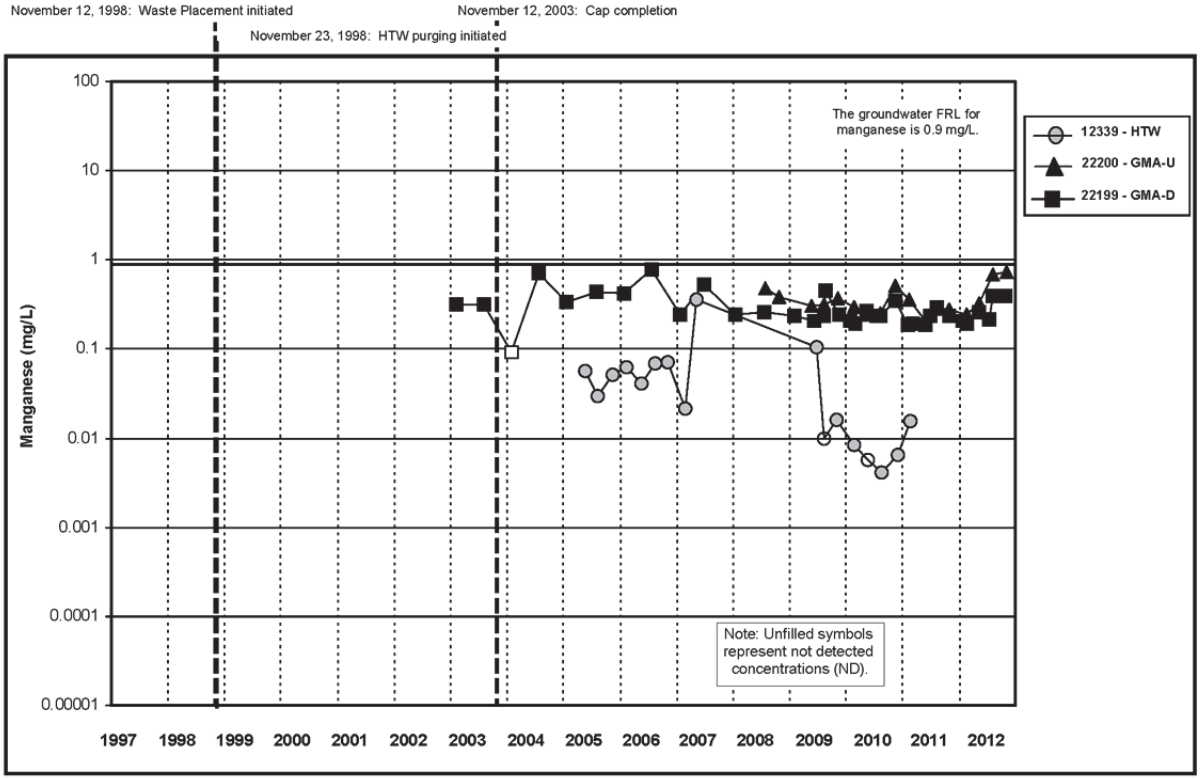


Figure A.5.2–23B. Cell 2 Manganese Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

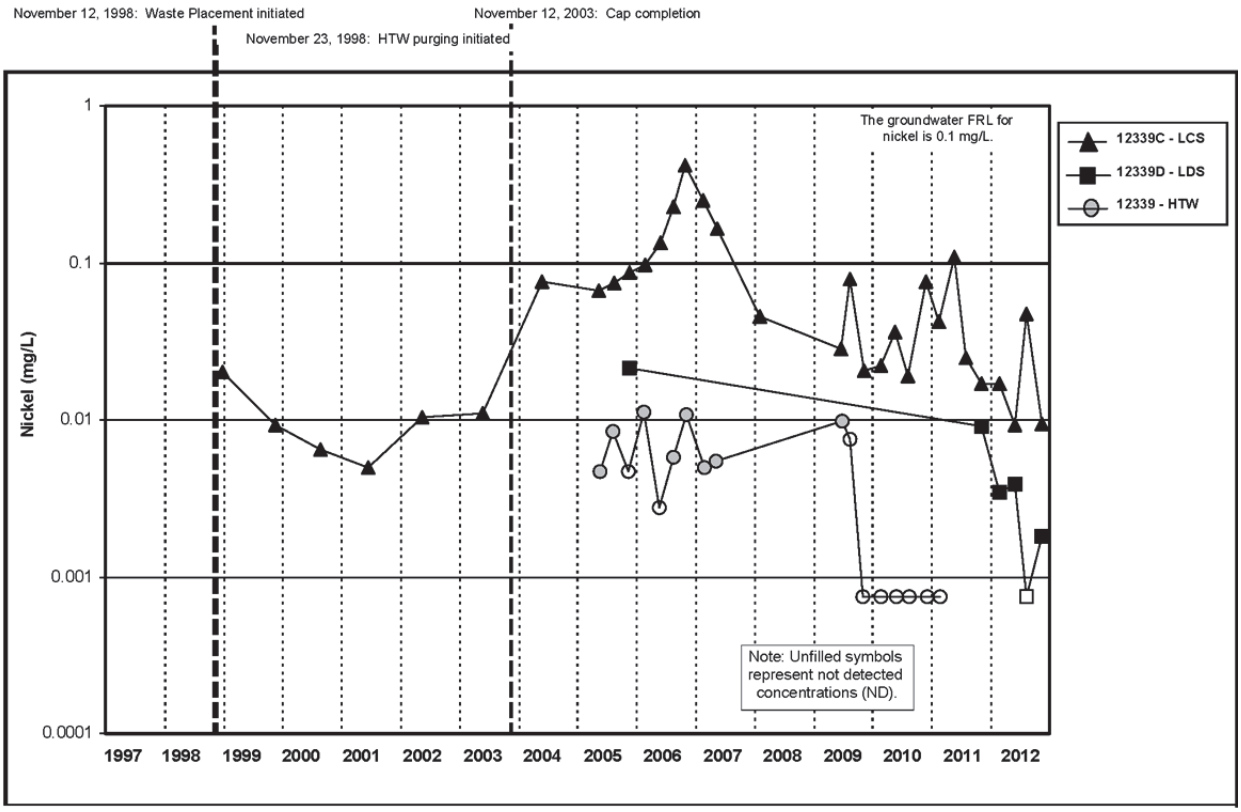


Figure A.5.2–24A. Cell 2 Nickel Concentration vs. Time Plot for LCS, LDS, and HTW

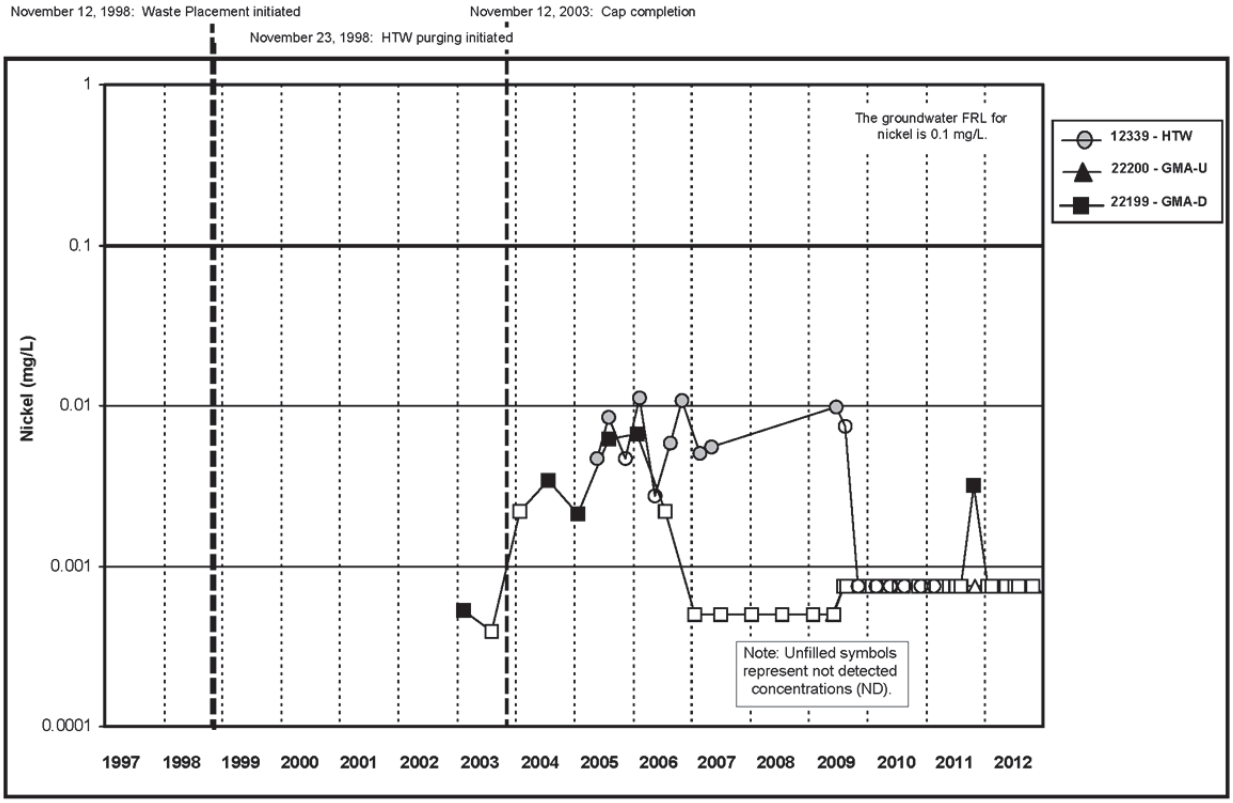


Figure A.5.2–24B. Cell 2 Nickel Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

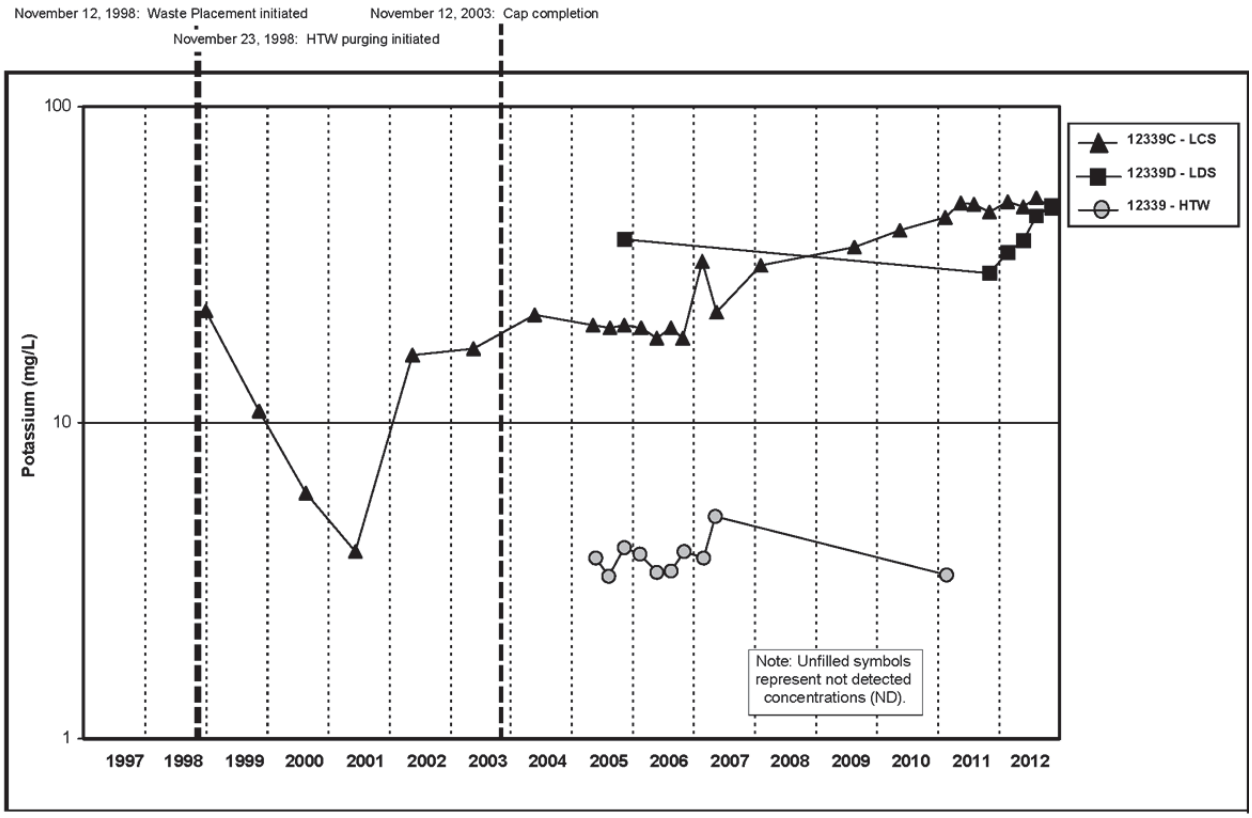


Figure A.5.2–25A. Cell 2 Potassium Concentration vs. Time Plot for LCS, LDS, and HTW

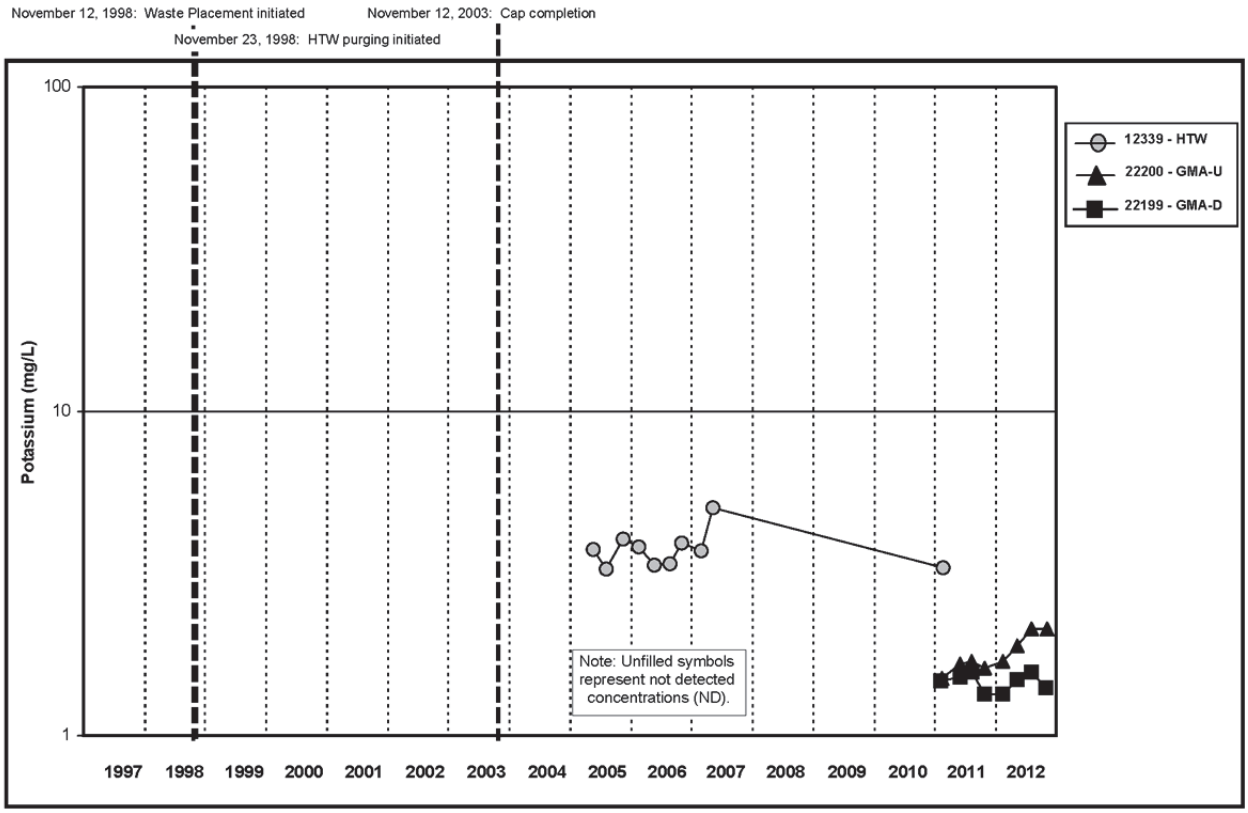


Figure A.5.2–25B. Cell 2 Potassium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

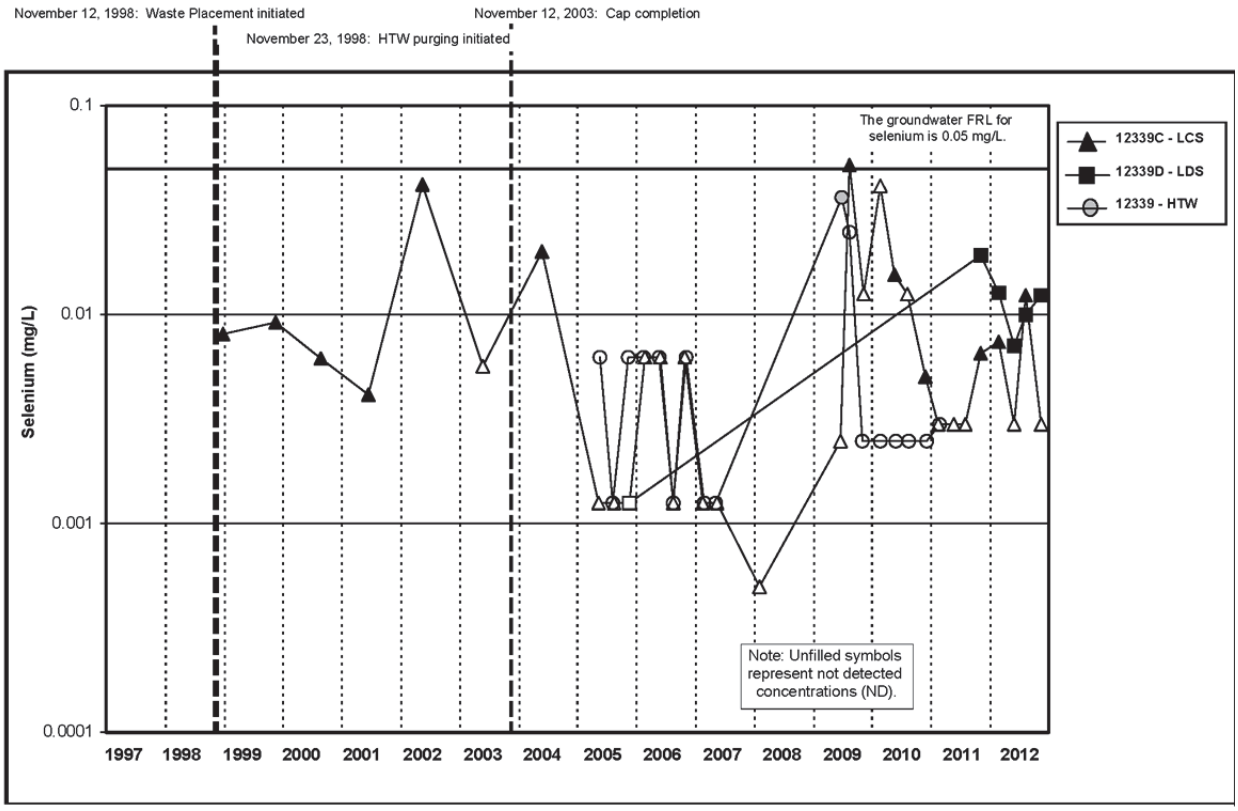


Figure A.5.2–26A. Cell 2 Selenium Concentration vs. Time Plot for LCS, LDS, and HTW

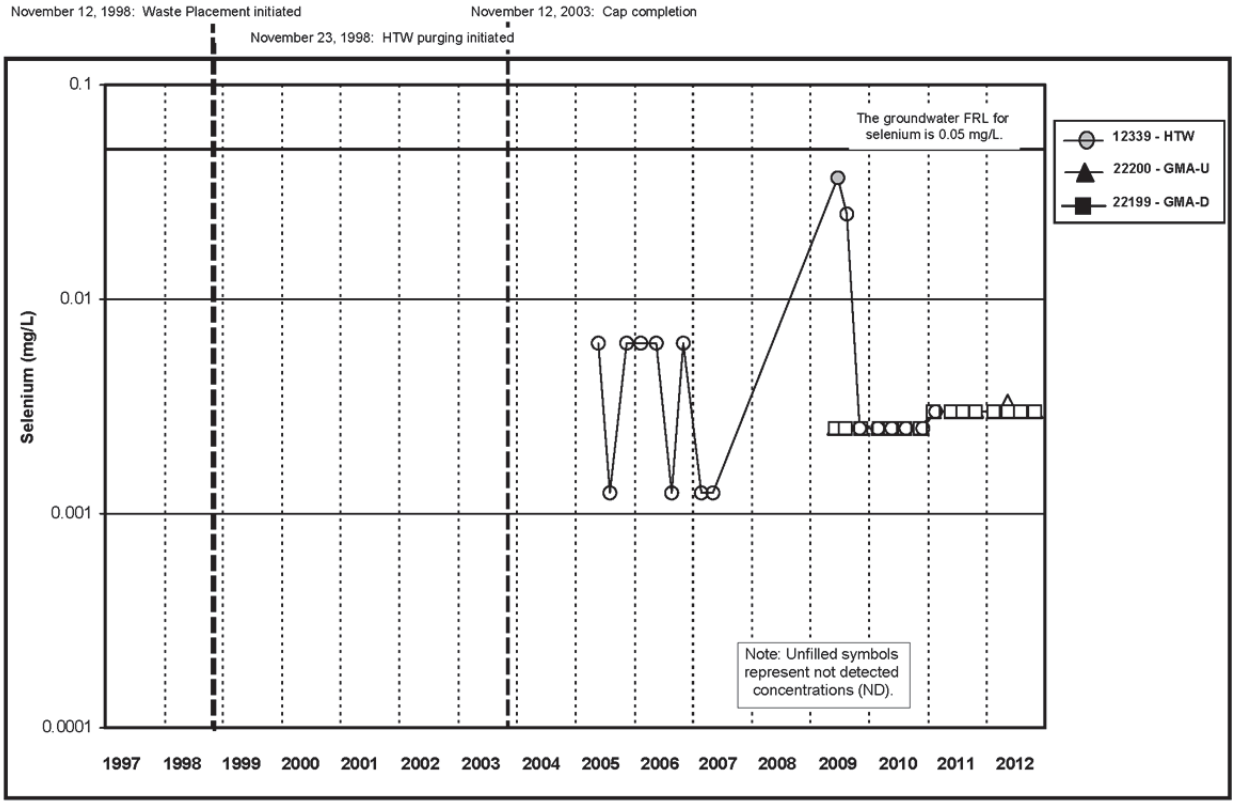


Figure A.5.2–26B. Cell 2 Selenium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

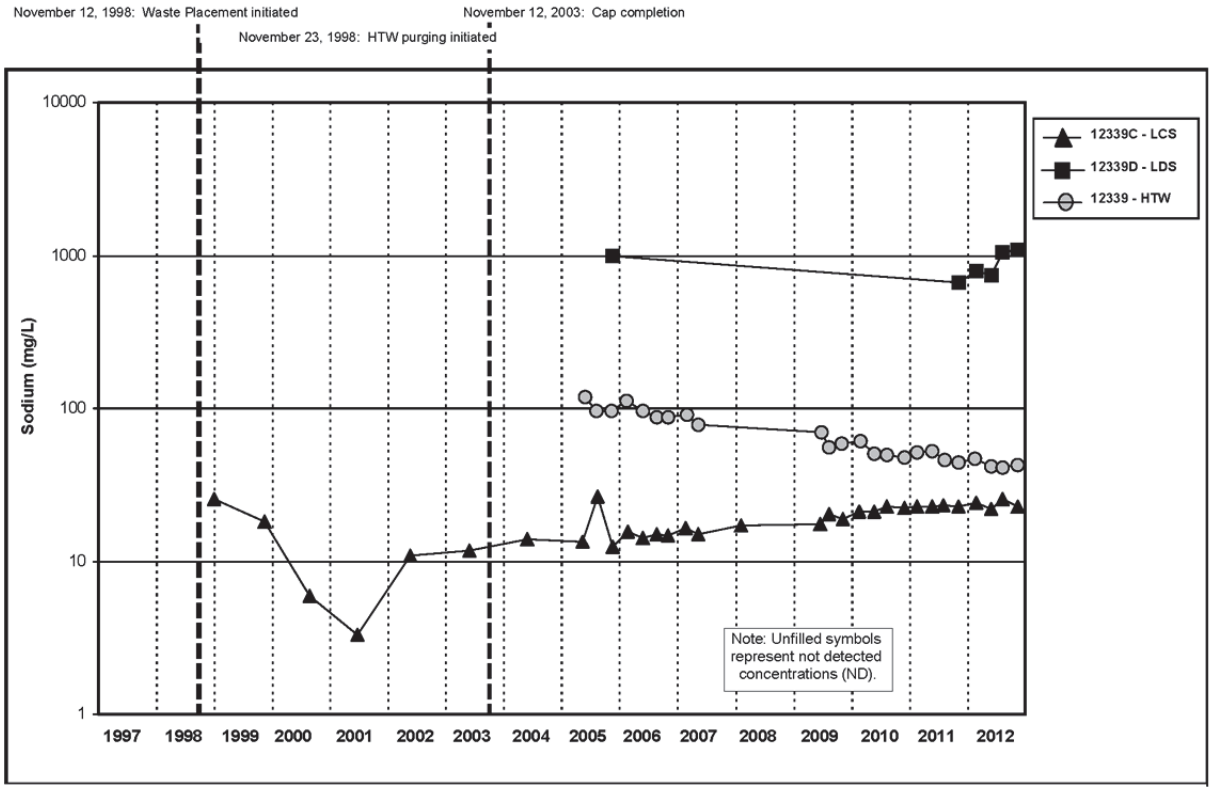


Figure A.5.2–27A. Cell 2 Sodium Concentration vs. Time Plot for LCS, LDS, and HTW

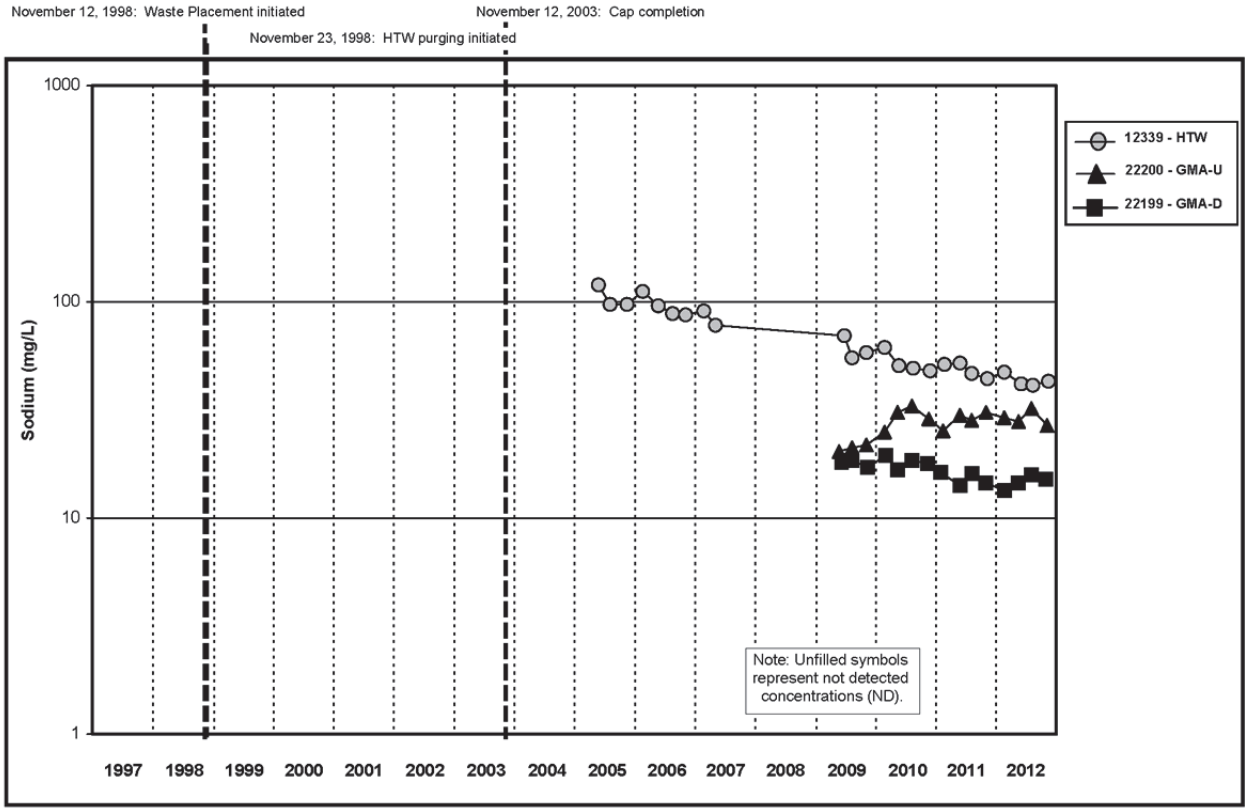


Figure A.5.2–27B. Cell 2 Sodium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

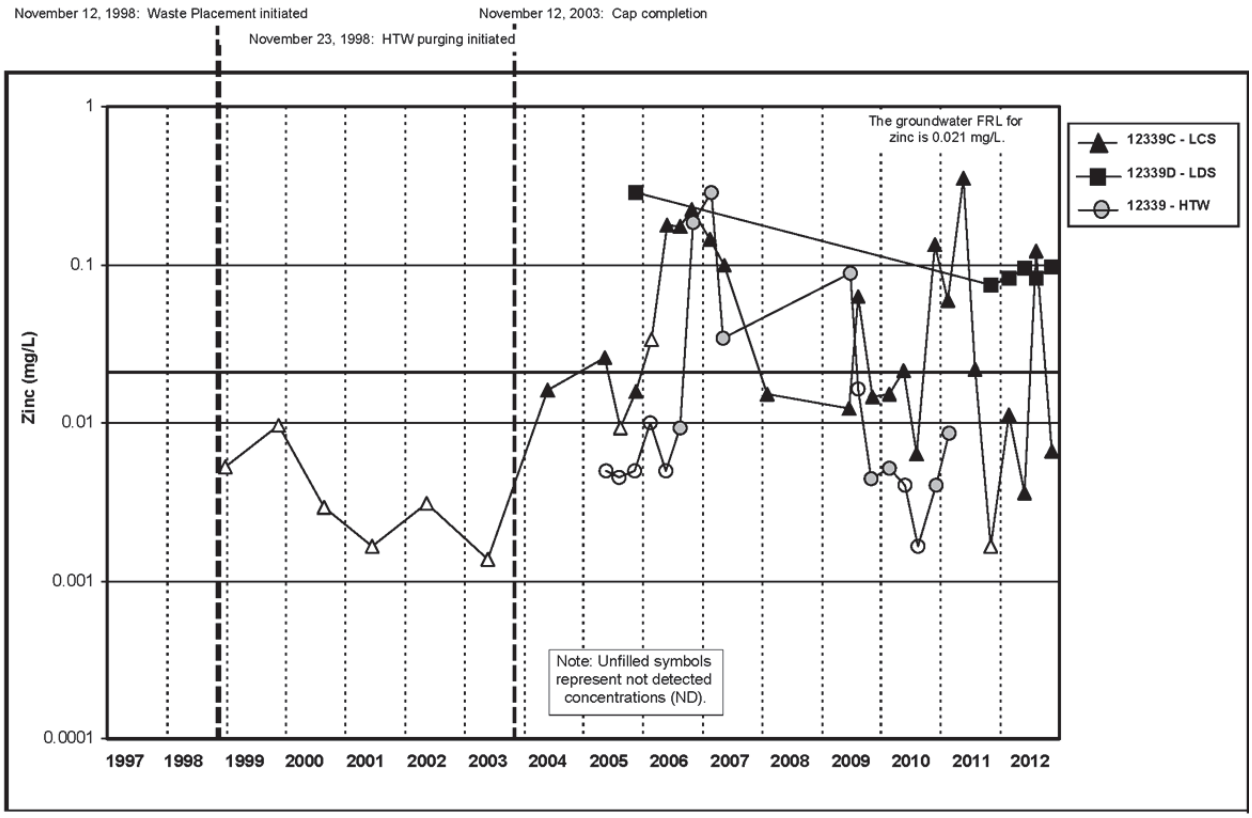


Figure A.5.2–28A. Cell 2 Zinc Concentration vs. Time Plot for LCS, LDS, and HTW

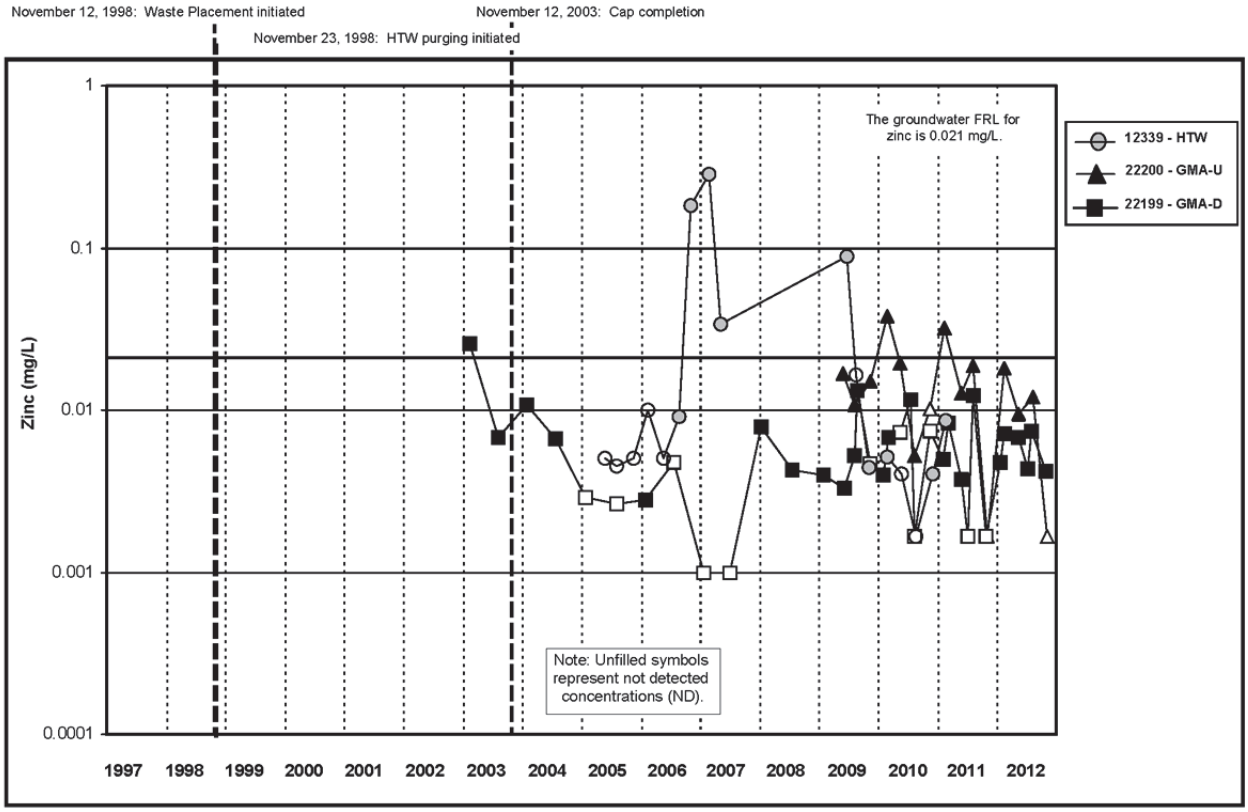


Figure A.5.2–28B. Cell 2 Zinc Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

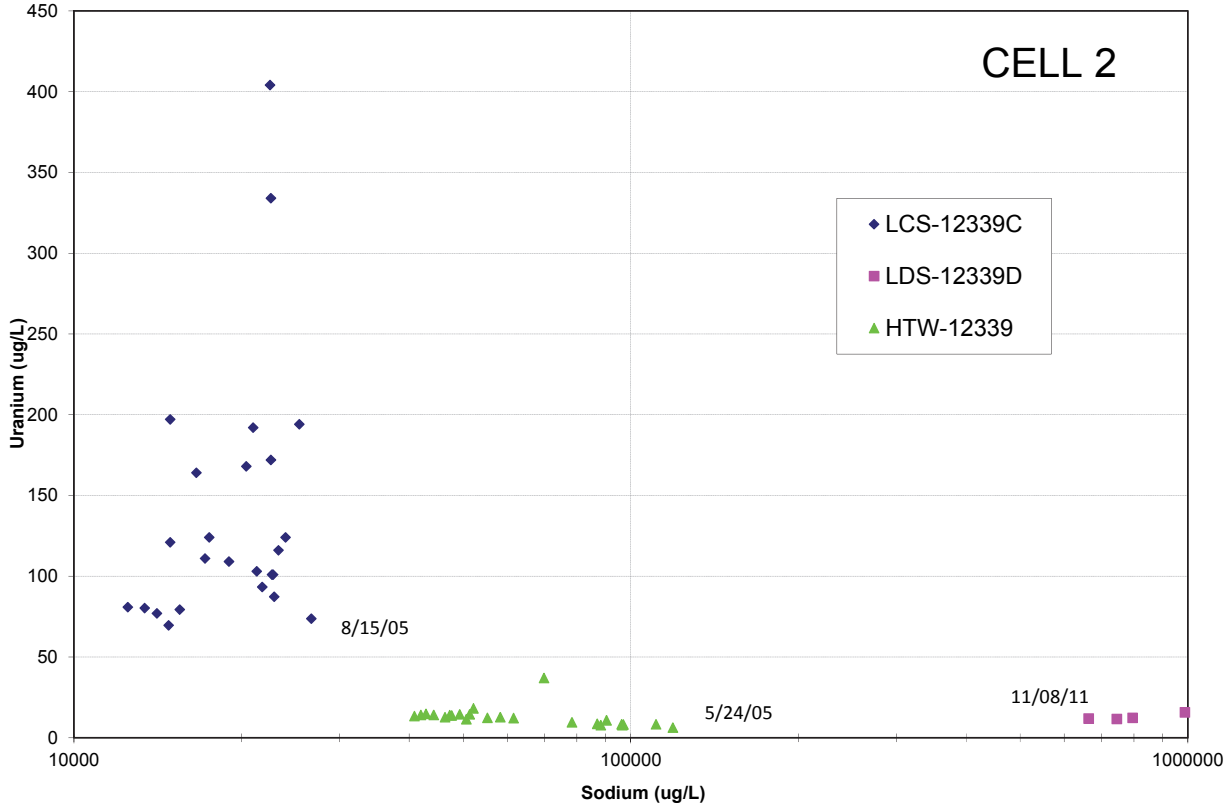


Figure A.5.2–29. Cell 2 Bivariate Plot for Uranium and Sodium

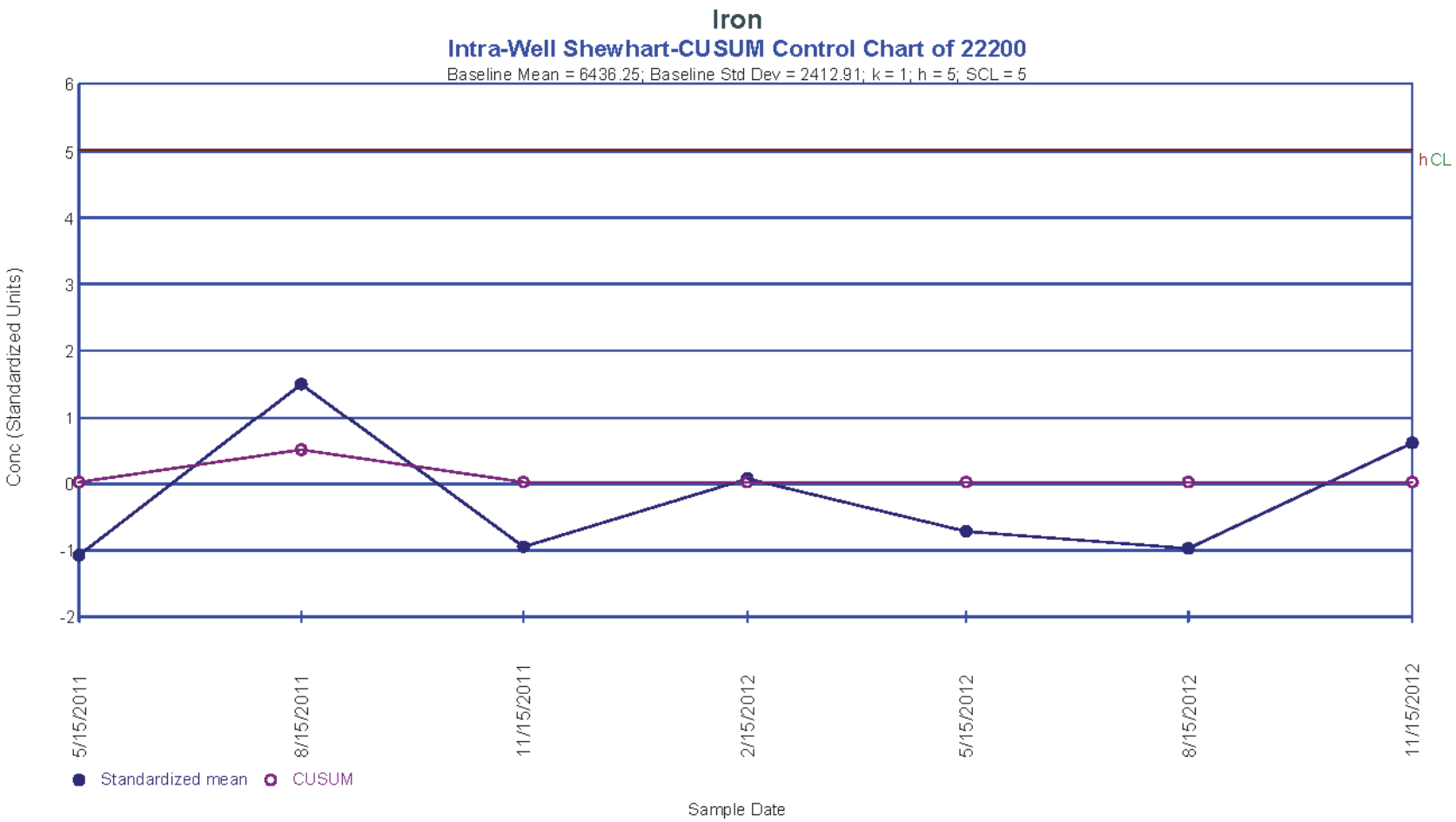


Figure A.5.2–30. Intra-Well Shewhart-CUSUM Control Chart (Iron 22200)

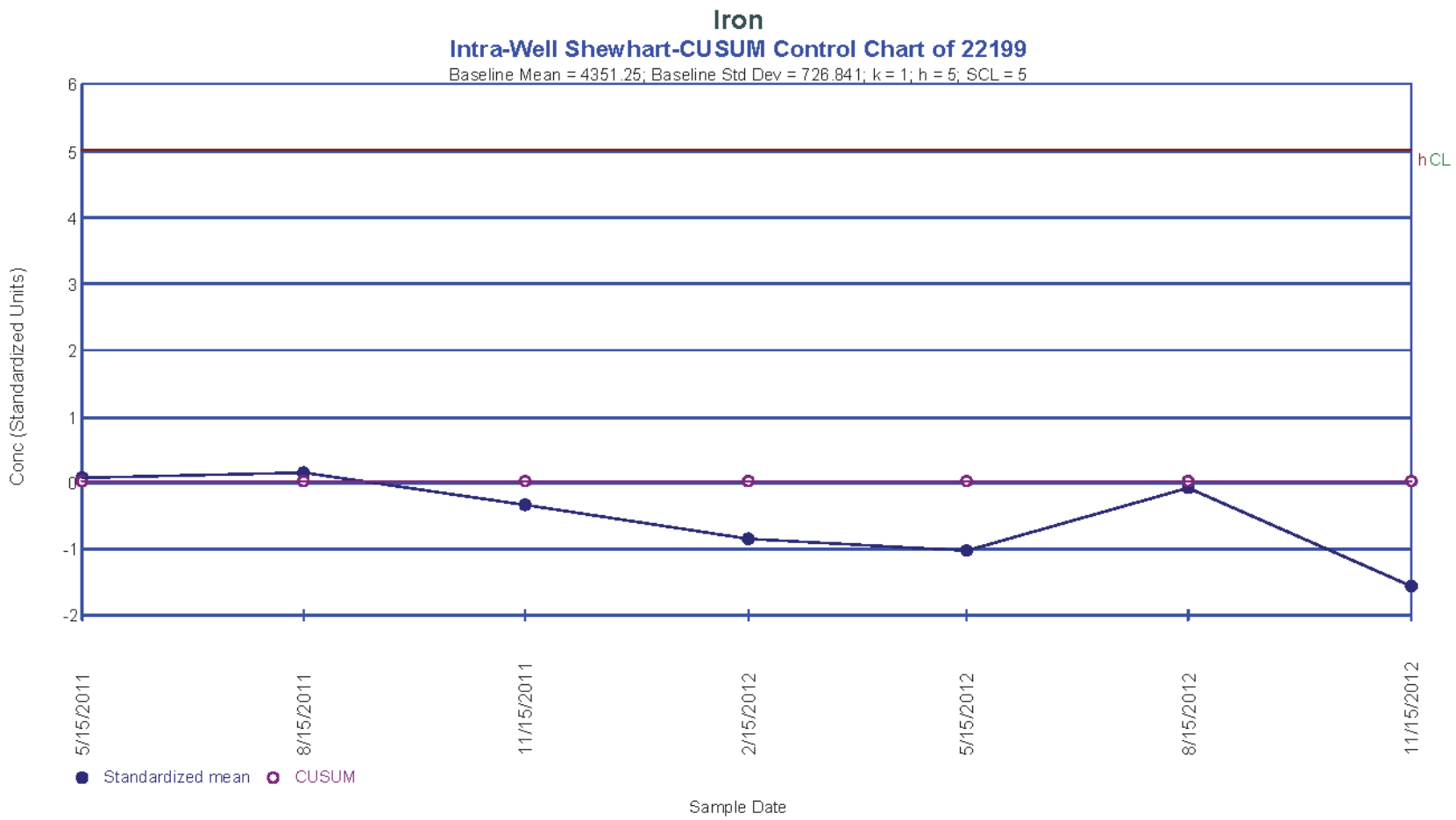


Figure A.5.2–31. Intra-Well Shewhart-CUSUM Control Chart (Iron 22199)

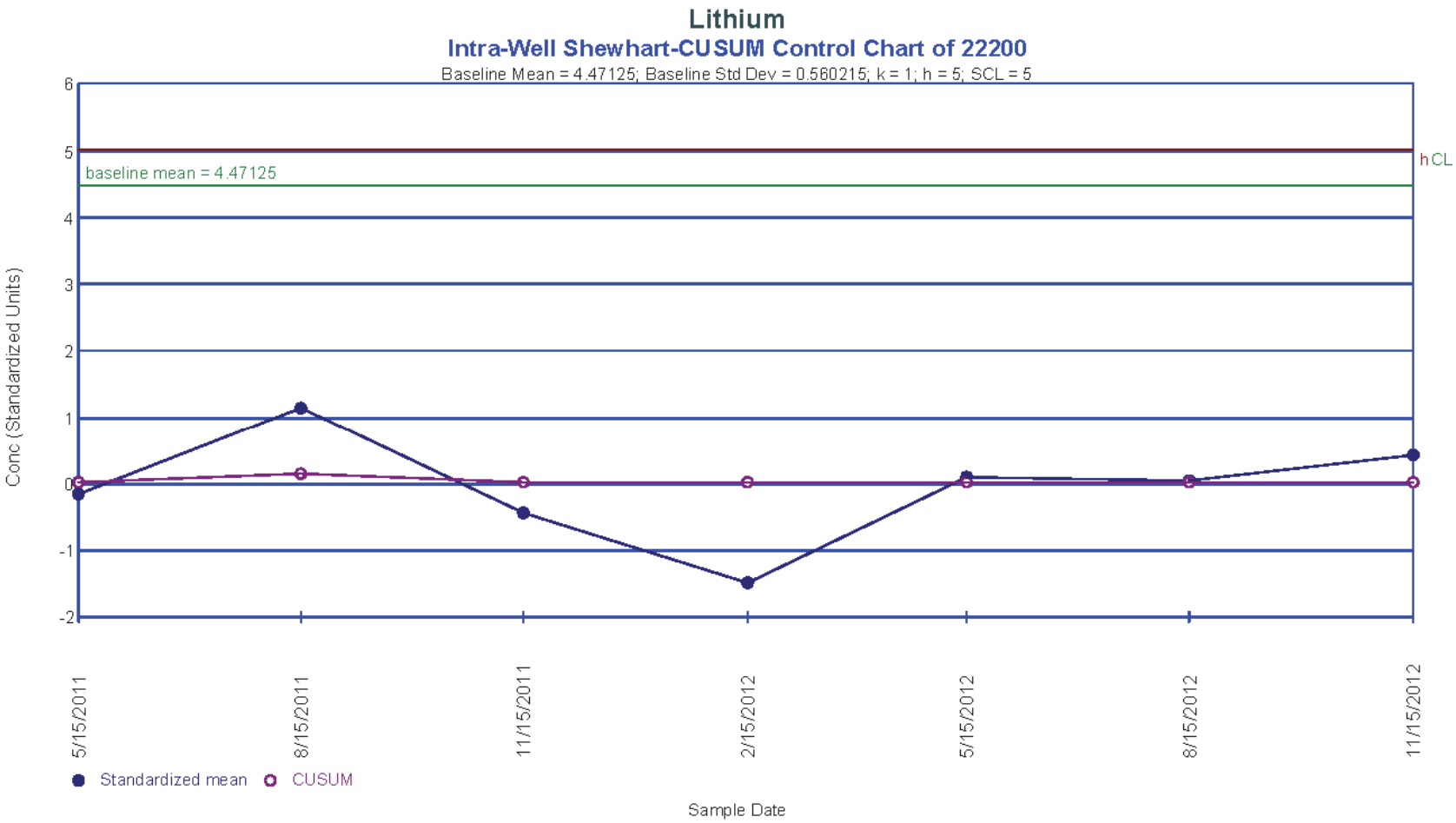


Figure A.5.2–32. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22200)

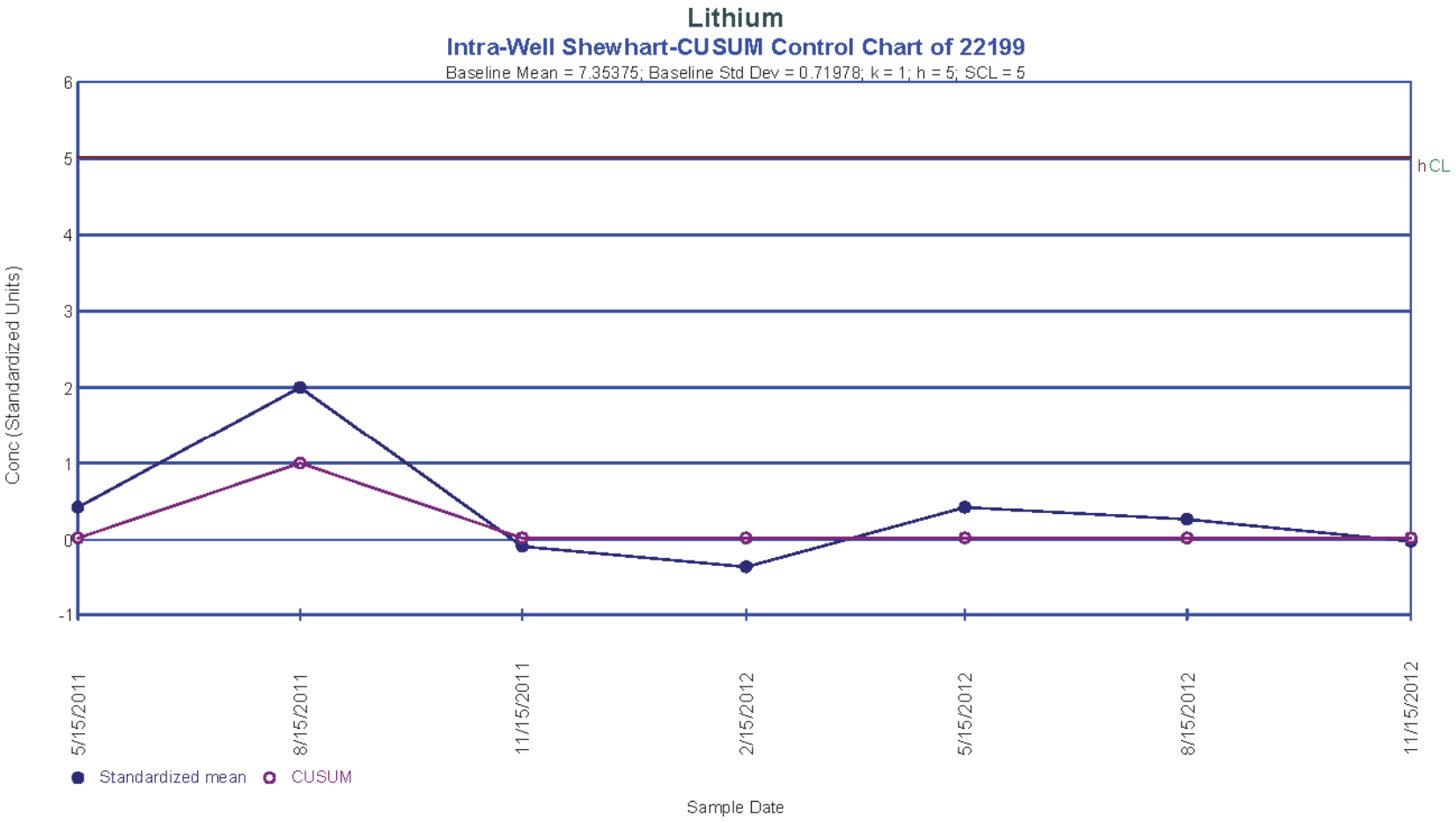


Figure A.5.2–33. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22199)

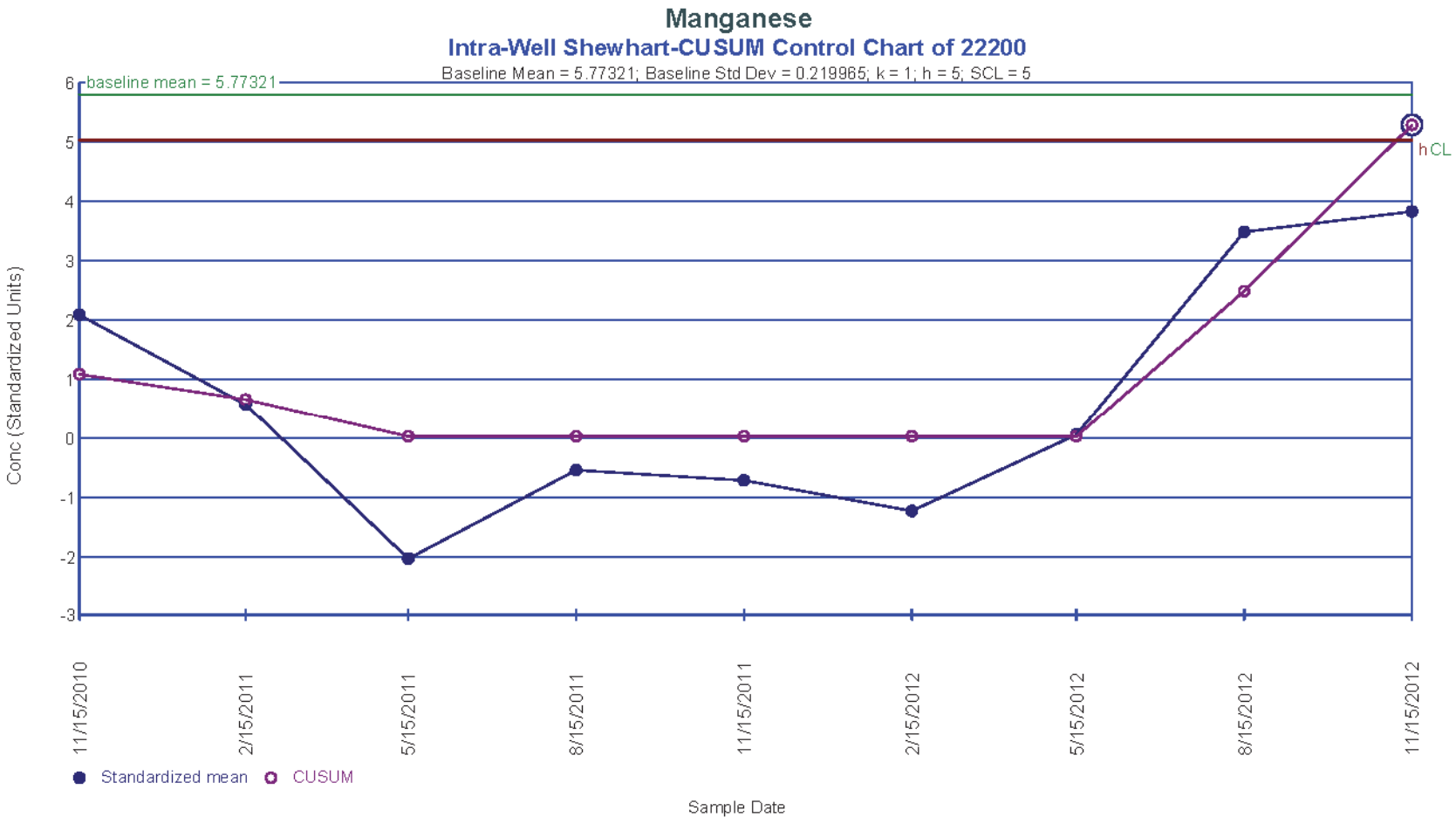


Figure A.5.2–34. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22200)

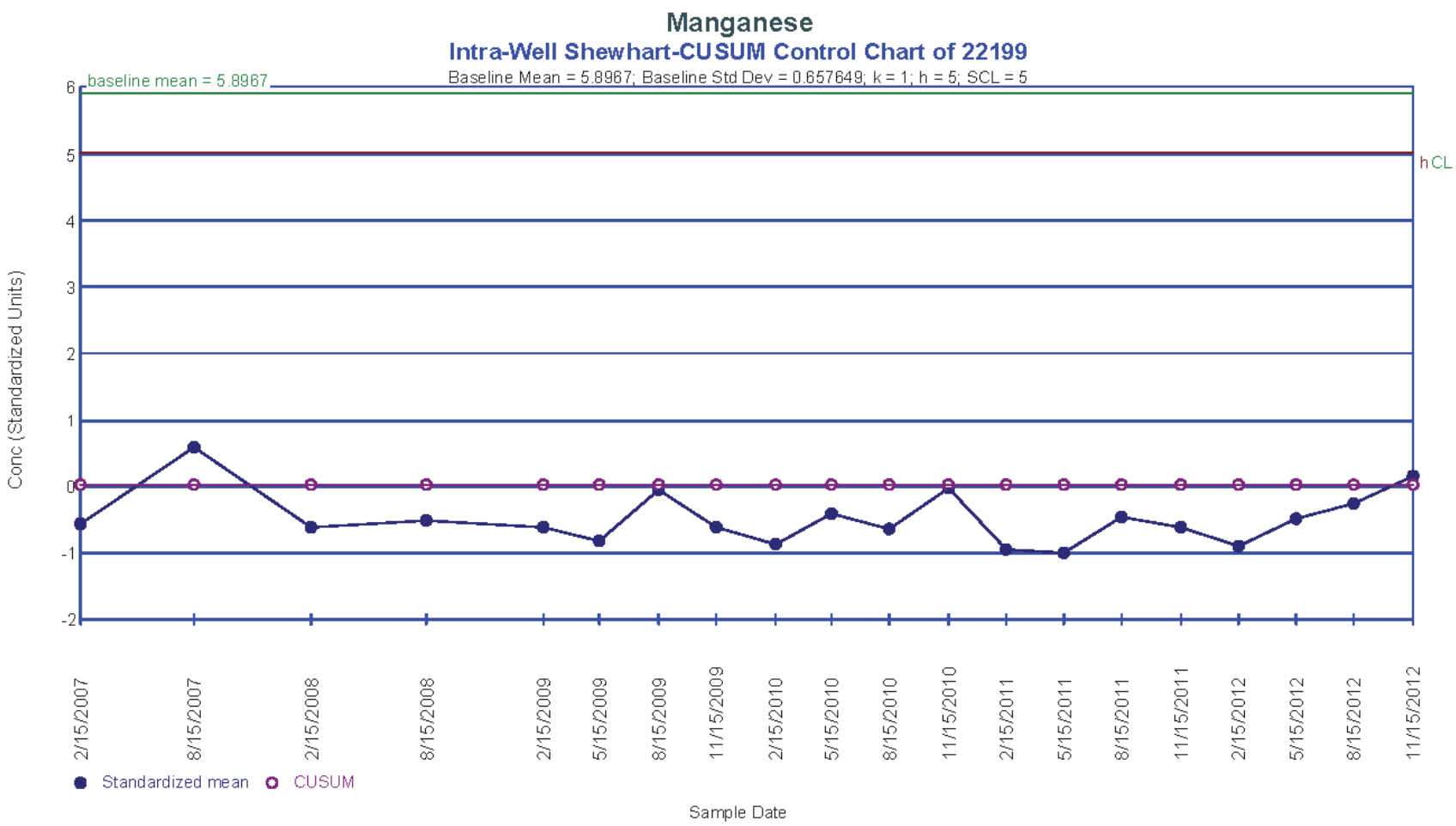


Figure A.5.2–35. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22199)

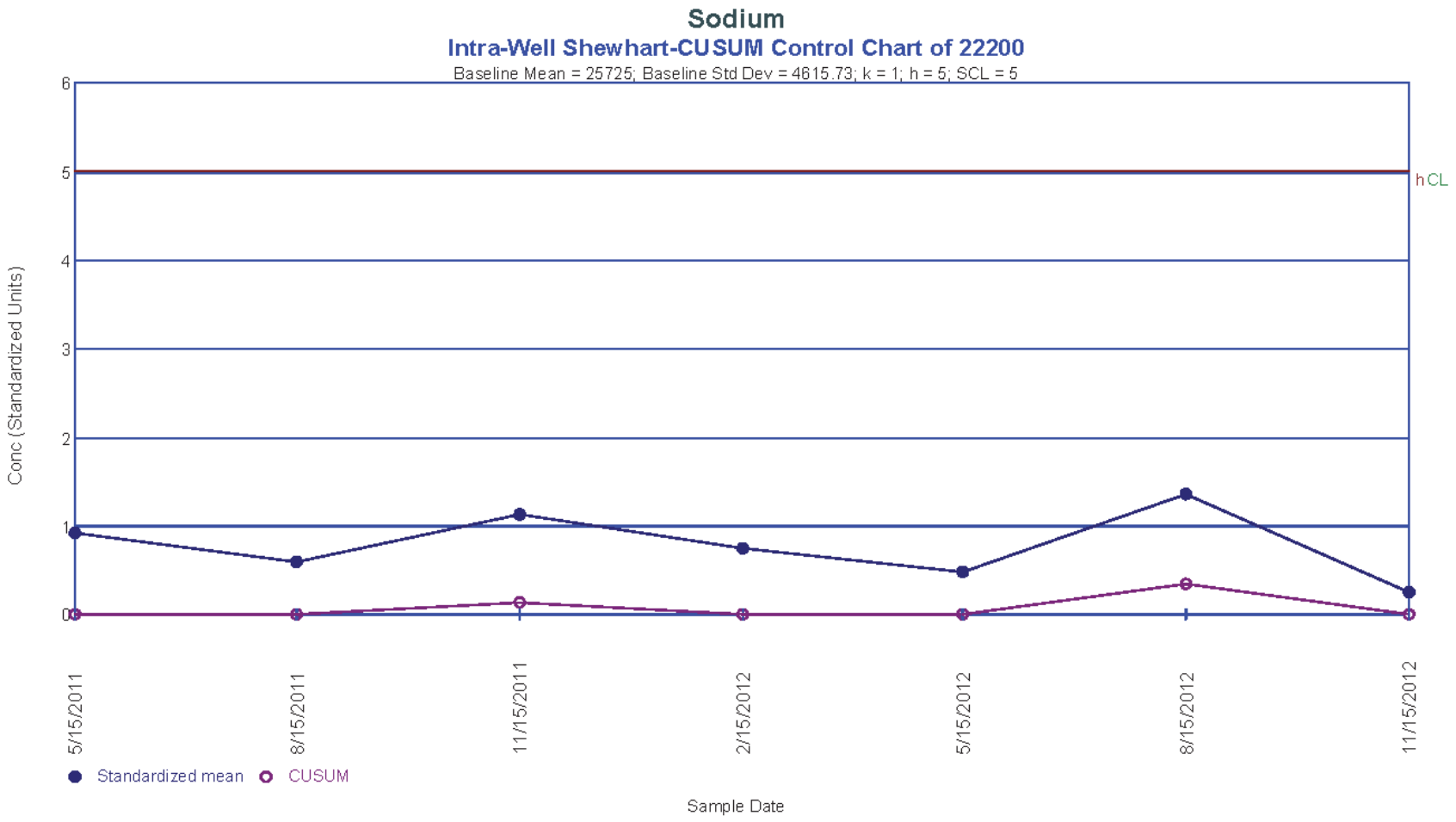


Figure A.5.2–36. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22200)

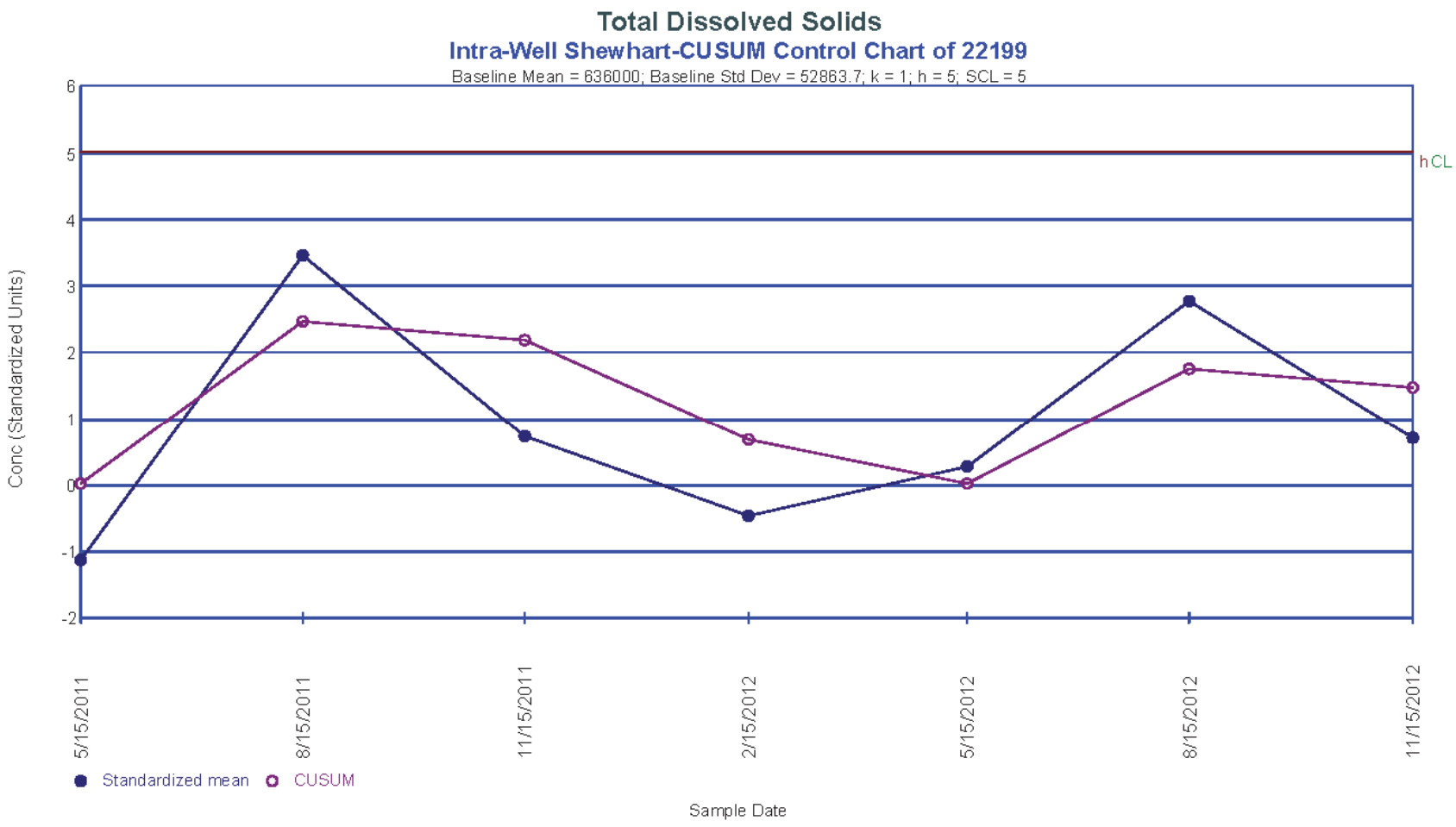


Figure A.5.2–37. Intra-Well Shewhart-CUSUM Control Chart (Total Dissolved Solids 22199)

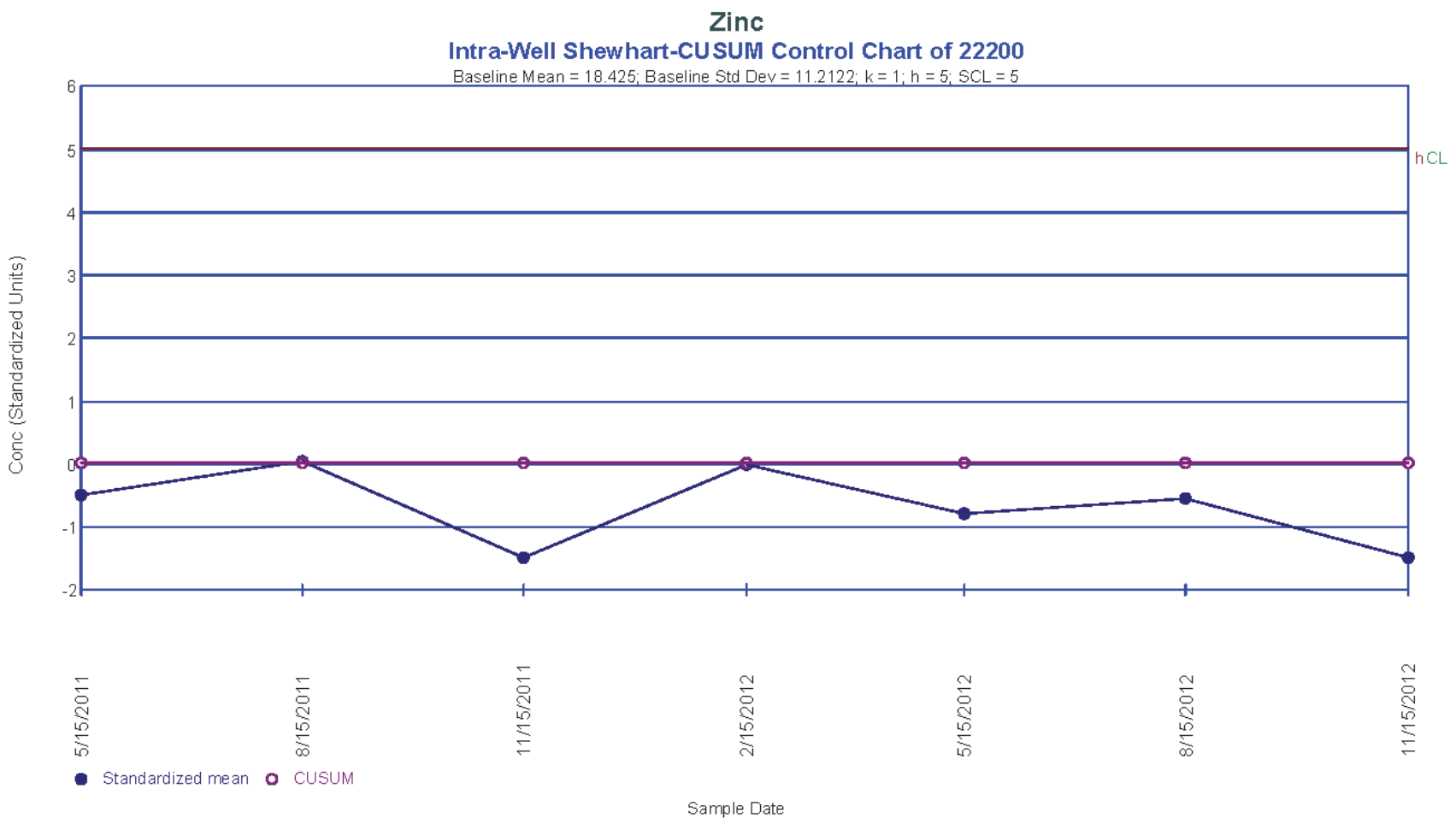


Figure A.5.2–38. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22200)

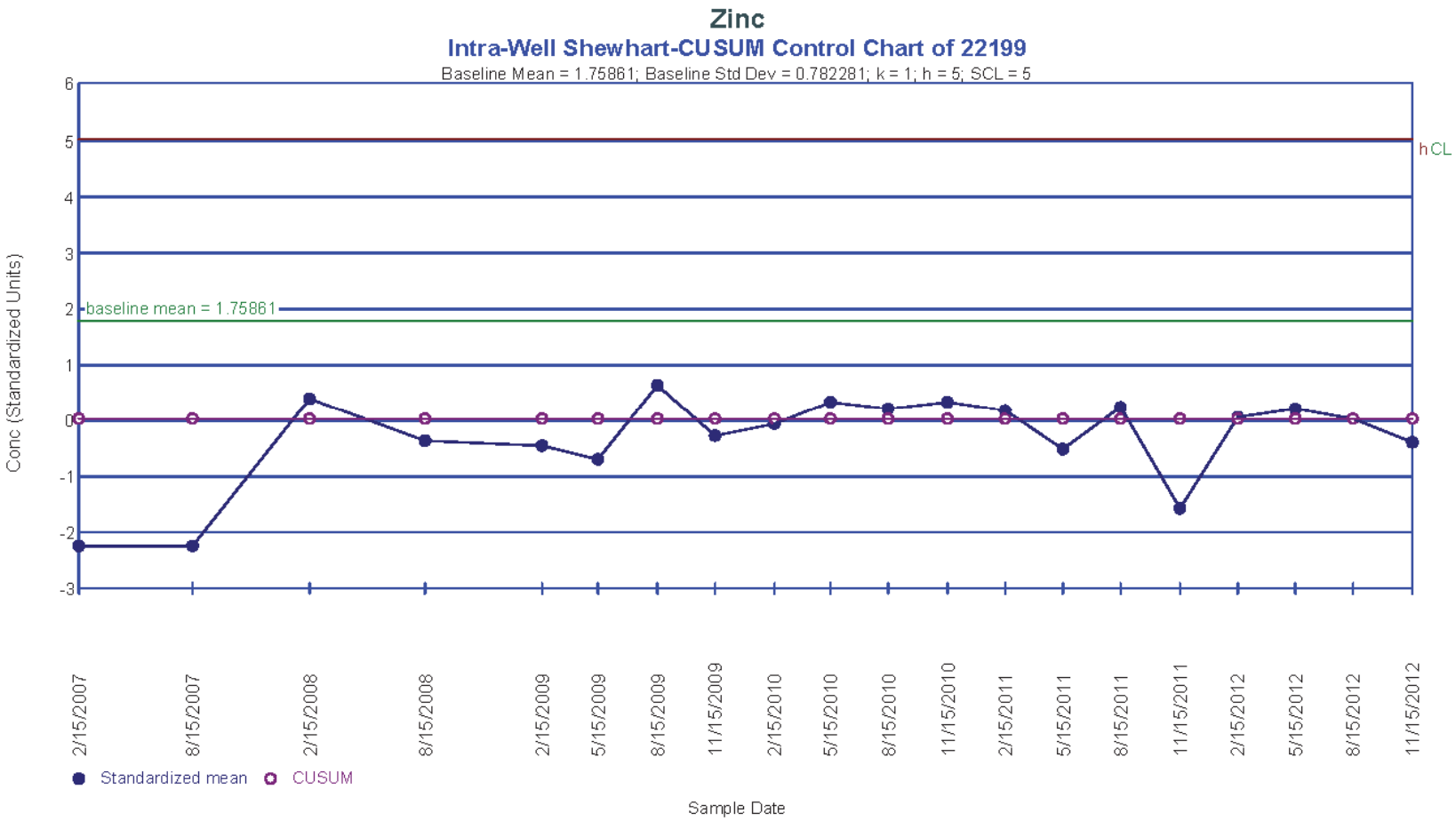


Figure A.5.2–39. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22199)

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Sub-attachment A.5.3

Cell 3

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The following information is provided in this sub-attachment:

- Quarterly monitoring summary statistics (refer to Table A.5.3–1)
- Annual LCS sample summary information for detected parameters (refer to Table A.5.3–2)
- LCS monthly accumulation volumes (refer to Figure A.5.3–1)
- LDS monthly accumulation volumes (refer to Figure A.5.3–2)
- OSDF horizontal till well 12340 water yield (refer to Figure A.5.3–3)
- GMA water levels and uranium concentration versus time (refer to Figures A.5.3–4 and A.5.3–5)
- Plots of concentration versus time (refer to Figures A.5.3–6A to A.5.3–28B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.3–29)
- Control charts (refer to Figures A.5.3–30 to A.5.3–38)

A.5.3.1 Quarterly Monitoring Results

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within the cell is sampled in the LCS and LDS. Water quality beneath the cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present the results.

In 2012, 23 parameters were sampled in the LCS, LDS, and GMA wells of each cell. HTWs in all cells were sampled quarterly for arsenic, uranium, sodium, and sulfate. The LDS of Cell 3 has been dry since 2007.

As shown in Table A.5.3–1, and summarized below, 6 parameters (uranium, TDS, TOC, arsenic, boron, and sodium) have upward trends in the HTW and/or the GMA wells based on the Mann-Kendall test for trend.

Parameters with upward concentration trends in the HTW and GMA Wells of Cell 3

Parameter	HTW[a] 12340	GMA-U[a] 22203	GMA-D[a] 22204
Total Uranium	Up	Up	Up
TDS		Up	
TOC			Up
Arsenic			Up
Boron		Up	Up
Sodium		Up	

[a] HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer; TDS=total dissolved solids; TOC=total organic carbon. No entry indicates that the trend was not up.

The (uranium-sodium) bivariate plot for the Cell 3 LCS, LDS, and HTW is provided in Figure A.5.3–29. The plot shows that the chemical signature for uranium-sodium in the LCS LDS, and HTW are separate and distinct, indicating that mixing between the horizons is not

occurring. Therefore, upward concentration trends measured beneath Cell 3 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

A.5.3.2 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background. The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 2009) defines the process of creating a Shewart-CUSUM control chart. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected, the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared "out of control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit.

A minimum of eight samples are recommended for use in ChemStat software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat software plots both a CUSUM control limit (h) and a SCL on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL.

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat software though, by default, plots both the SCL and CUSUM (h) control limit on the charts. As a "work-a-round," the SCL limit was defined as five to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

As shown in Table A.5.3–1 in gray shading, six parameters in the HTW and GMA wells of Cell 3 meet the criteria for control charts (i.e., more than eight samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in nine control charts.

These nine control charts are presented in Figures A.5.3–30 through A.5.3–38. All of the control charts for Cell 3 exhibit "in control" conditions.

Parameter and Monitoring Point[a]	Assessment	Figure Number
Iron in the GMA-U	In Control	A.5.3–30
Lithium in the GMA-U	In Control	A.5.3–31
Lithium in the GMA-D	In Control	A.5.3–32
Manganese in the GMA-U	In Control	A.5.3–33
Manganese in the GMA-D	In Control	A.5.3–34
Sulfate in the GMA-D	In Control	A.5.3–35
TDS in the GMA-D	In Control	A.5.3–36
Zinc in the GMA-U	In Control	A.5.3–37
Zinc in the GMA-D	In Control	A.5.3–38

[a] GMA-D = downgradient Great Miami Aquifer; GMA-U = upgradient Great Miami Aquifer; TDS=total dissolved solids

A.5.3.3 Annual LCS Sample Results

Annual LCS sampling results for Cell 3 are provided in Table A.5.3–2 for those parameters that have been detected at least once and are not being sampled quarterly. No new Appendix I or PCB parameters were detected in the LCS of Cell 3 in 2012.

A.5.3.4 Summary and Conclusions

- The LDS of Cell 3 has been dry since 2007.
- Six parameters monitored quarterly have an upward concentration trend in the HTW and/or GMA wells of Cell 3: iron, lithium, manganese, sulfate, TDS, and zinc.
- Separate and distinct chemical signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 3 indicate that water is not mixing between the horizons. Therefore, upward concentration trends beneath Cell 3 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell, and not to cell performance.
- Nine control charts were constructed for Cell 3 parameters. All of the control charts exhibit “in control” conditions.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 3 in 2012.

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Table A.5.3–1. Summary Statistics for Cell 3

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Total Uranium (µg/L)	LCS	12340C	52	52	100	9.35	113	65.8	26.8	Normal	Up	Detected	
	LDS	12340D	21	21	100	8.90	27.7	17.0	5.0	Normal	Down	Not Detected	72.4(Q3-04)
	HTW	12340	55	55	100	3.89	29.3	19.8	6.8	Undefined	Up	Detected	58.5(Q3-09)
	GMA-U	22203	54	57	94.7	ND	9.51	2.34	2.21	LogNormal	Up	Detected	
	GMA-D	22204	57	58	98.3	ND	22.9	5.80	5.13	LogNormal	Up	Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12340C	27	27	100	72.0	1080	485	197	Undefined	None	Detected	
	LDS	12340D	9	9	100	108	267	161	54	Normal	None	Not Detected	693(Q4-05)
	GMA-U	22203	8	8	100	385	451	406	21	Normal	None	Not Detected	
	GMA-D	22204	8	8	100	269	381	372	37	Undefined	None	Not Detected	
Chloride (mg/L)	LCS	12340C	27	27	100	4.7	52.1	36.7	14.1	Undefined	Up	Detected	
	LDS	12340D	9	9	100	54.1	74.2	61.8	6.5	Normal	None	Not Detected	
	GMA-U	22203	8	8	100	21.5	44.0	34.0	7.0	Normal	None	Not Detected	
	GMA-D	22204	8	8	100	19.0	26.1	21.4	2.1	Normal	None	Not Detected	
Nitrate, Nitrite (mg/L)	LCS	12340C	23	34	67.6	ND	2.20	0.220	0.588	Undefined	Down	Detected	
	LDS	12340D	6	9	66.7	ND	5.71	1.06	1.92	LogNormal	None	Not Detected	
	GMA-U	22203	1	8	12.5	ND	0.025	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22204	0	8	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Sulfate (mg/L)	LCS	12340C	44	44	100	26.1	2650	1730	580	Undefined	Up	Detected	
	LDS	12340D	19	19	100	112	2510	1250	700	Undefined	Down	Not Detected	
	HTW	12340	34	34	100	352	958	683	159	Normal	Down	Detected	
	GMA-U	22203	39	39	100	64.2	4020	209	622	Undefined	Down	Detected	
	GMA-D	22204	39	39	100	232	779	485	149	Normal	None	Not Detected	
Total Dissolved Solids (mg/L)	LCS	12340C	33	33	100	233	3490	3180	1180	Undefined	Up	Detected	
	LDS	12340D	0	0	0	NA	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-U	22203	15	15	100	524	1190	711	187	LogNormal	Up	Not Detected	
	GMA-D	22204	15	15	100	724	1530	1060	230	Normal	None	Not Detected	
Total Organic Carbon (mg/L)	LCS	12340C	39	51	76.5	ND	4.21	2.05	0.74	Normal	Up	Detected	17.4(Q4-99)
	LDS	12340D	17	21	81.0	ND	8.02	5.77	2.26	Undefined	None	Not Detected	
	GMA-U	22203	43	57	75.4	ND	2.90	1.62	0.54	Normal	None	Detected	5.66(Q1-00) 14.1(Q4-00)
	GMA-D	22204	40	57	70.2	ND	2.92	1.51	0.53	Normal	Up	Detected	8.83(Q1-00)
Total Organic Halogens (mg/L)	LCS	12340C	20	52	38.5	ND	0.0590	0.0125	0.0133	Undefined	Down	Detected	0.141(Q4-99)
	LDS	12340D	10	21	47.6	ND	0.0838	0.0251	0.0187	LogNormal	None	Not Detected	
	GMA-U	22203	25	57	43.9	ND	0.0213	0.0052	0.0058	Undefined	Down	Detected	0.213(Q2-00)0.075(Q2-10)
	GMA-D	22204	12	57	21.0	ND	0.0194	0.00435	0.00520	Undefined	Down	Detected	0.165(Q2-00)
Arsenic (mg/L)	LCS	12340C	7	32	21.9	ND	0.131	0.0025	0.0284	Undefined	Up	Detected	
	LDS	12340D	1	9	11.1	ND	0.0085	Insufficient	Insufficient	Undefined	None	Not Detected	
	HTW	12340	3	24	12.5	ND	0.025	0.0025	Insufficient	Undefined	None	Not Detected	
	GMA-U	22203	3	15	20.0	ND	0.0372	0.0025	Insufficient	Undefined	None	Not Detected	
	GMA-D	22204	5	28	17.9	ND	0.0382	0.0025	0.0103	Undefined	Up	Detected	
Barium (mg/L)	LCS	12340C	27	27	100	0.0276	0.118	0.0454	0.0189	Undefined	Down	Detected	
	LDS	12340D	9	9	100	0.0135	0.0386	0.0196	0.0078	LogNormal	None	Not Detected	
	GMA-U	22203	8	8	100	0.0638	0.141	0.103	0.030	Normal	None	Not Detected	
	GMA-D	22204	8	8	100	0.0352	0.0592	0.0440	0.0088	Normal	None	Not Detected	
Boron (mg/L)	LCS	12340C	52	53	98.1	ND	9.19	4.50	2.08	Undefined	Up	Detected	
	LDS	12340D	20	21	95.2	ND	0.557	0.128	0.149	Undefined	Down	Detected	
	GMA-U	22203	46	57	80.7	ND	0.0748	0.0436	0.0143	Normal	Up	Detected	
	GMA-D	22204	49	57	86.0	ND	8.87	0.0450	0.0169	Normal	Up	Detected	

Table A.5.3−1 (continued). Summary Statistics for Cell 3

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Calcium (mg/L)	LCS	12340C	27	27	100	50.3	666	605	196	Undefined	Up	Detected	1,200(Q4-05)
	LDS	12340D	9	9	100	121	363	199	71	Normal	None	Not Detected	
	GMA-U	22203	8	8	100	135	264	189	47	Normal	None	Not Detected	
	GMA-D	22204	8	8	100	179	365	276	61	Normal	None	Not Detected	
Cobalt (mg/L)	LCS	12340C	20	32	62.5	ND	0.0666	0.00172	0.0179	Undefined	None	Detected	
	LDS	12340D	8	9	88.9	ND	0.0011	0.0007	0.0003	Normal	None	Not Detected	
	GMA-U	22203	1	15	6.7	ND	0.0013	Insufficient	Insufficient	Undefined	None	Detected	
	GMA-D	22204	4	15	26.7	ND	0.00176	0.0005	0.0005	Undefined	None	Not Detected	
Copper (mg/L)	LCS	12340C	21	28	75.0	ND	0.0311	0.0061	0.0071	Undefined	None	Detected	
	LDS	12340D	6	9	66.7	ND	0.0160	0.0081	0.0049	Normal	None	Not Detected	
	GMA-U	22203	7	8	87.5	ND	0.0102	0.0052	0.0038	Normal	None	Not Detected	
	GMA-D	22204	7	8	87.5	ND	0.0119	0.0059	0.0040	Normal	None	Not Detected	
Iron (mg/L)	LCS	12340C	31	32	96.9	ND	16.6	3.31	3.62	LogNormal	None	Detected	
	LDS	12340D	8	9	88.9	ND	2.14	1.22	0.53	Normal	None	Not Detected	
	GMA-U	22203	15	15	100	2.85	33.2	10.9	7.9	LogNormal	None	Not Detected	
	GMA-D	22204	15	15	100	3.15	11.3	5.55	2.25	LogNormal	Down	Not Detected	
Lithium (mg/L)	LCS	12340C	24	24	100	0.683	1.02	0.817	0.098	LogNormal	None	Detected	
	LDS	12340D	9	9	100	0.0313	0.0645	0.0427	0.0106	Normal	Down	Not Detected	
	GMA-U	22203	15	15	100	0.00577	0.0119	0.0084	0.0020	Normal	None	Not Detected	
	GMA-D	22204	15	15	100	0.00694	0.0102	0.0085	0.0011	Normal	None	Not Detected	
Magnesium (mg/L)	LCS	12340C	27	27	100	10.2	380	198	85	Undefined	Up	Detected	
	LDS	12340D	9	9	100	87.2	138	110	15	Normal	None	Not Detected	
	GMA-U	22203	8	8	100	32.5	58.1	42.8	8.0	Normal	None	Not Detected	
	GMA-D	22204	8	8	100	40.4	66.6	54.4	9.3	Normal	None	Not Detected	
Manganese (mg/L)	LCS	12340C	31	32	96.9	ND	7.27	0.266	2.65	Undefined	None	Detected	
	LDS	12340D	8	9	88.9	ND	0.146	0.0256	0.0463	LogNormal	None	Not Detected	
	GMA-U	22203	17	17	100	0.202	0.688	0.377	0.147	Normal	None	Not Detected	
	GMA-D	22204	27	28	96.4	ND	3.01	1.37	0.52	Normal	None	Not Detected	
Nickel (mg/L)	LCS	12340C	32	32	100	0.0021	0.102	0.0102	0.0349	Undefined	Up	Detected	
	LDS	12340D	9	9	100	0.0034	0.0097	0.0062	0.0019	Normal	None	Not Detected	
	GMA-U	22203	2	15	13.3	ND	0.00219	Insufficient	Insufficient	Undefined	None	Detected	
	GMA-D	22204	11	28	39.3	ND	0.0127	0.00102	0.00302	Undefined	None	Not Detected	
Potassium (mg/L)	LCS	12340C	27	27	100	0.575	35.0	27.1	10.2	Undefined	Up	Detected	
	LDS	12340D	9	9	100	9.47	15.7	11.8	1.8	Normal	None	Not Detected	
	GMA-U	22203	8	8	100	2.12	3.5	2.77	0.44	Normal	None	Not Detected	
	GMA-D	22204	8	8	100	2.03	3.07	2.56	0.33	Normal	None	Not Detected	

Table A.5.3−1 (continued). Summary Statistics for Cell 3

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Selenium (mg/L)	LCS	12340C	5	32	15.6	ND	0.03925	0.0058	0.0073	LogNormal	None	Not Detected	
	LDS	12340D	0	9	0	ND	NA	0.0012	0.0026	Undefined	None	Not Detected	
	GMA-U	22203	1	15	6.7	ND	0.00617	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-D	22204	0	15	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Sodium (mg/L)	LCS	12340C	32	32	100	4.35	49.9	26.2	9.3	Undefined	Up	Not Detected	
	LDS	12340D	9	9	100	263	344	315	27	Normal	None	Not Detected	
	HTW	12340	24	24	100	29.0	74.1	47.1	14.4	LogNormal	Down	Detected	
	GMA-U	22203	15	15	100	18.5	28.3	22.4	2.9	Normal	Up	Detected	
	GMA-D	22204	15	15	100	14.2	20.5	17.1	2.0	Normal	Down	Detected	
Zinc (mg/L)	LCS	12340C	23	32	71.9	ND	0.042	0.0163	0.0097	Normal	None	Not Detected	
	LDS	12340D	8	9	88.9	ND	0.499	0.161	0.175	LogNormal	None	Not Detected	
	GMA-U	22203	10	15	66.7	ND	0.013	0.0067	0.0035	Normal	None	Not Detected	
	GMA-D	22204	21	28	75.0	ND	0.0405	0.0113	0.0088	LogNormal	None	Not Detected	

Note 1: Shading identifies a horizontal till well or Great Miami Aquifer well, with more than 8 samples, normal or lognormal distribution, no trend, and no serial correlation. These wells meet control chart criteria.

Note 2: Data used in this table has been standardized to quarterly.

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]ND = not detected; NA = not applicable

[c]Averages were determined based on the distribution assumption.

[d]Insufficient is used for Distribution Type, Trend, or Serial Correlation whenever there is not enough data to run the test, for average whenever there is less than 4 detetions, and for standard deviation whenever there are less than 5 detections.

[e]Data distribution based on the Shapiro-Wilk statistic.

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[f]Trend based on nonparametric Mann-Kendall procedure.

[g]Serial correlation based on Rank Von Neumann test.

[h]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 25).

[i]Q = quarterly

Table A.5.3–2. Cell 3 Annual LCS Sample Summary Information for Detected Parameters

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	DETECTED IN 2012	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)
General Chemistry											
Ammonia (mg/L)	15	4	26.7	Yes	0.0242	0.274	0.117	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganics											
Beryllium (mg/L)	15	1	6.7	No	0.0002	-	-	0.004 mg/L(0)	-	-	0.0343 mg/L(0)
Cadmium (mg/L)	15	3	20.0	No	0.000065	0.00044	0.0002	0.014 mg/L(0)	0.014 mg/L(0)	-	0.05 mg/L(0)
Chromium (mg/L)	15	8	53.3	Yes	0.00093	0.006	0.0026	0.022 mg/L[g](0)	0.021 mg/L(0)	0.0046 mg/L(2)	0.818 mg/L(0)
Lead (mg/L)	15	2	13.3	No	0.00146	0.0266	0.014	0.015 mg/L(1)	0.022 mg/L(1)	0.0016 mg/L(1)	0.0114 mg/L(1)
Thallium (mg/L)	15	1	6.7	No	0.0021	-	-	-	-	-	0.0028 mg/L(0)
Vanadium (mg/L)	15	3	20.0	No	0.0034	0.00959	0.0056	0.038 mg/L(0)	0.012 mg/L(0)	0.005 mg/L(1)	0.299 mg/L(0)
Radionuclides											
Technetium-99 (pCi/L)	25	2	8.0	No	3.84	9.89	6.86	94 pCi/L(0)	22 pCi/L(0)	30 pCi/L(0)	6130 pCi/L(0)
Organics											
1,1-Dichloroethane (ug/L)	10	2	20.0	No	0.351	0.79	0.570	280 ug/L(0)	-	-	-
1,1-Dichloroethene (ug/L)	31	10	31.2	No	0.112	13.1	4.45	7 ug/L(3)	-	-	-
1,1,1-Trichloroethane (ug/L)	11	2	18.2	No	0.54	0.64	0.59	-	-	-	-
4-Nitroaniline	23	1	4.3	No	2.94	-	-	-	-	-	-
Bromodichloromethane (ug/L)	24	1	4.2	No	0.5	-	-	100 ug/L(0)	-	-	-
Chlorodibromomethane (ug/L)	11	1	9.1	No	1	-	-	-	-	-	-
Trans-1,3-dichloropropene (ug/L)	10	1	10.0	No	1	-	-	-	-	-	-
Vinyl chloride (ug/L)	24	2	8.3	No	0.539	16.1	8.32	2 ug/L(1)	-	-	-

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on hexavalent chromium from Operable Unit 5 Record of Decision, Table 9-4.

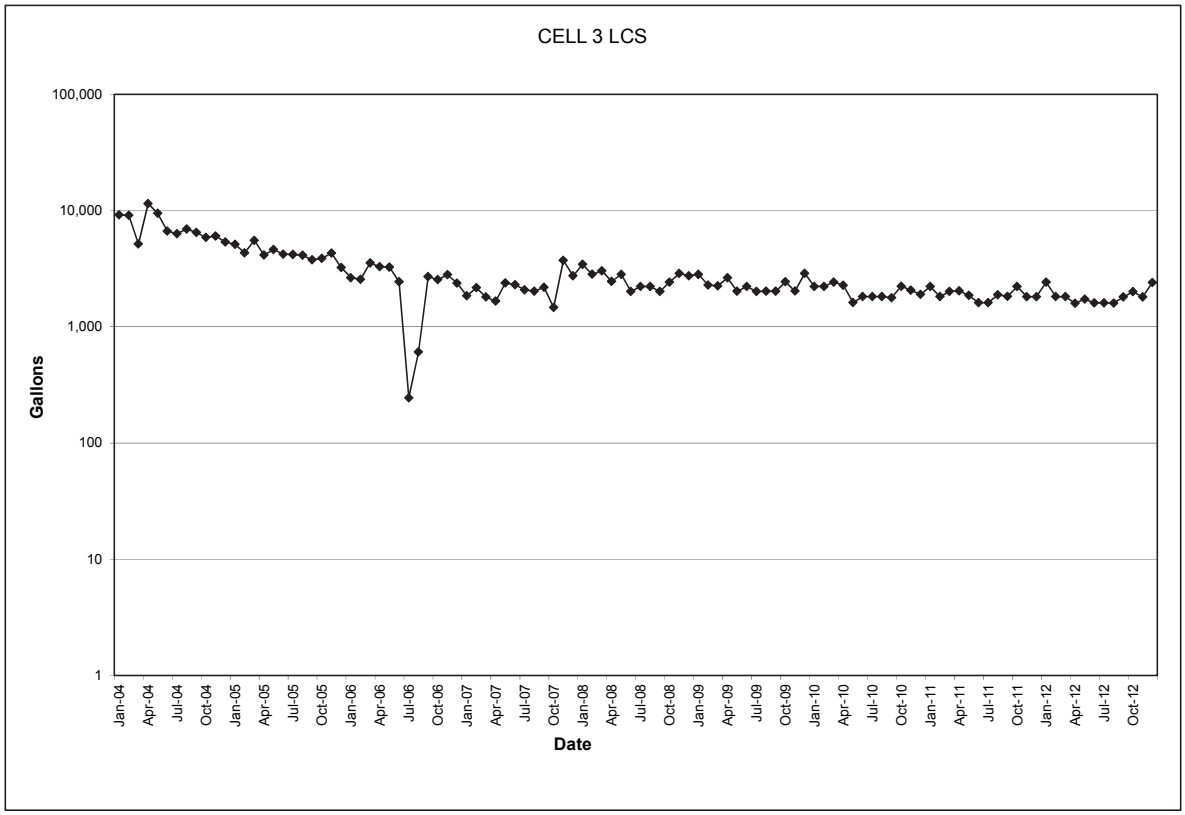


Figure A.5.3–1. Monthly Accumulation Volumes for Cell 3 LCS

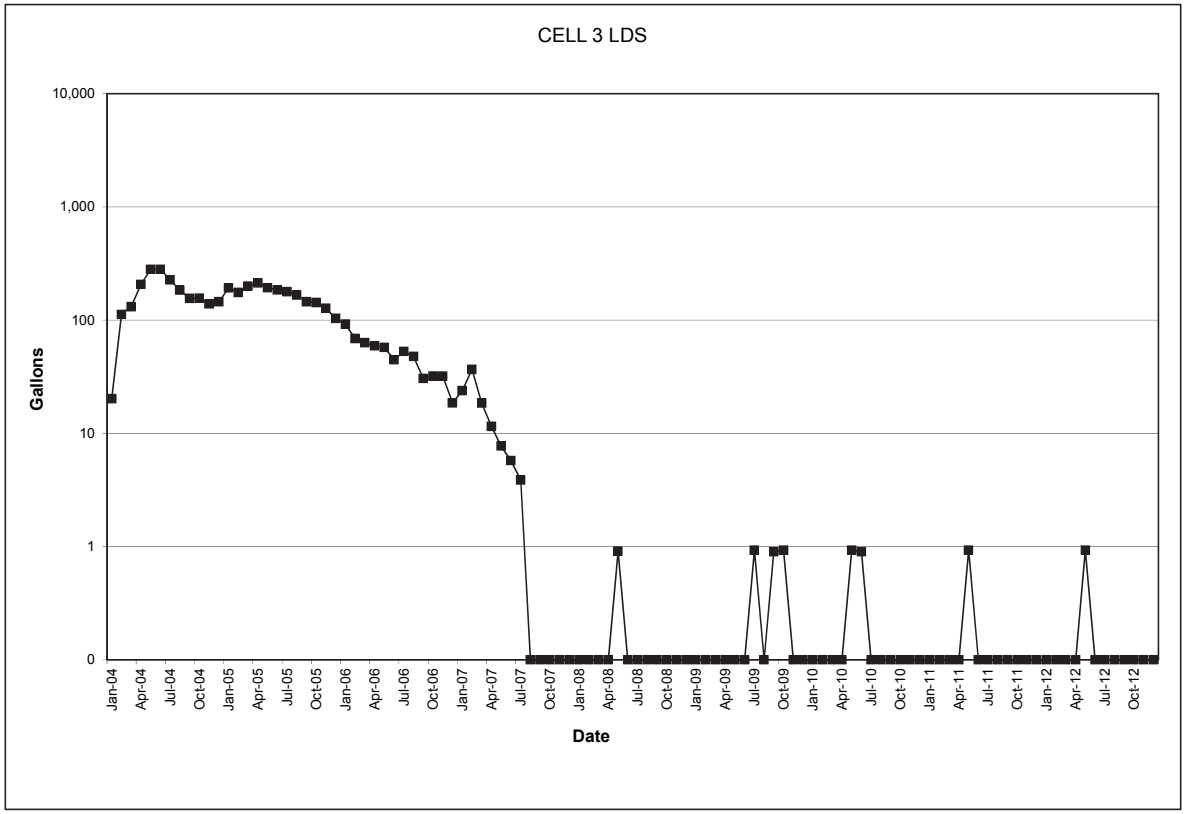
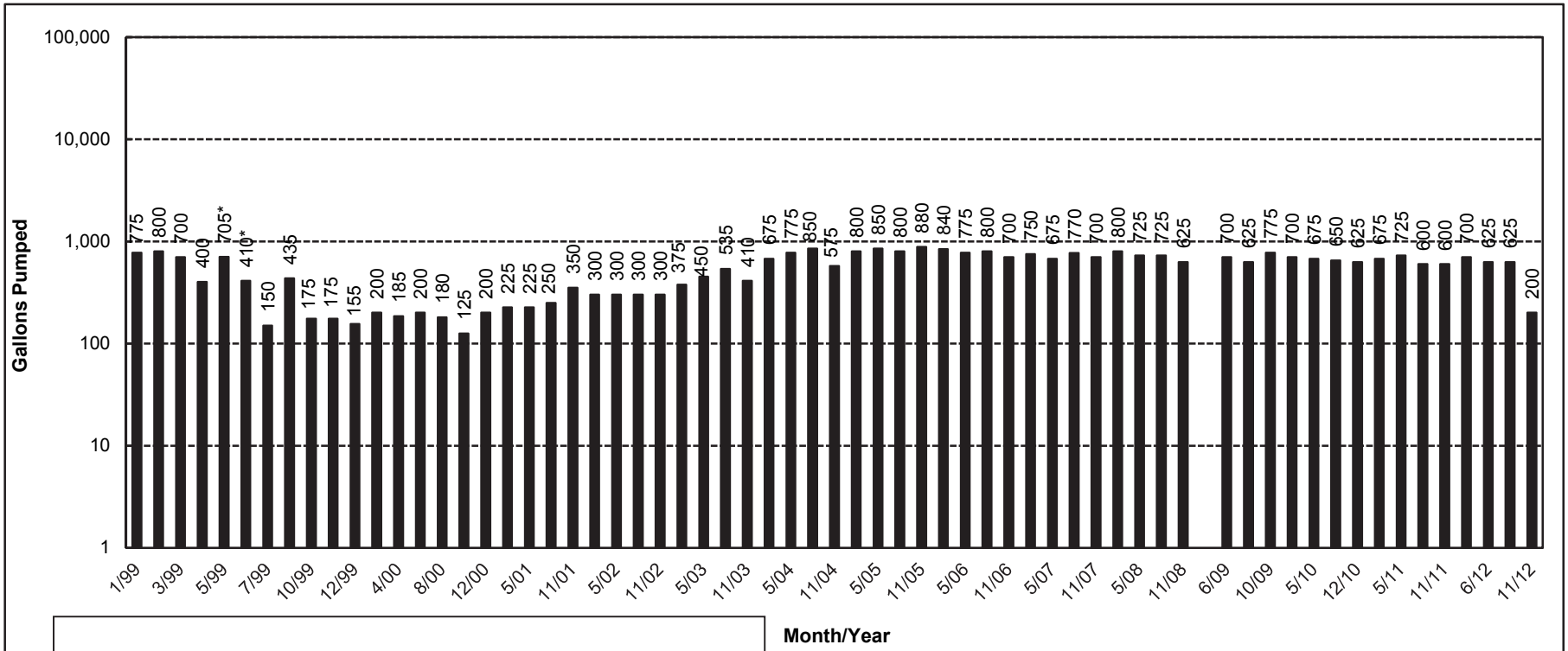


Figure A.5.3–2. Monthly Accumulation Volumes for Cell 3 LDS



12340 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
1999:	4880	n=11	444
2000:	1090	n= 6	182
2001:	1050	n= 4	263
2002:	1200	n= 4	300
2003:	1770	n= 4	443
2004:	2875	n= 4	719
2005:	3330	n=4	833
2006:	3115	n=4	779
2007:	2895	n=4	724
2008:	2875	n=4	719
2009:	2100	n=3	700
2010:	2650	n=4	663
2011:	2600	n=4	650
2012:	2150	n=4	538
Overall:			540

*More than one purge of the well was completed during these months to help evaluate well yield.

Figure A.5.3–3. OSDF Horizontal Till Well 12340 (Cell 3) Water Yield

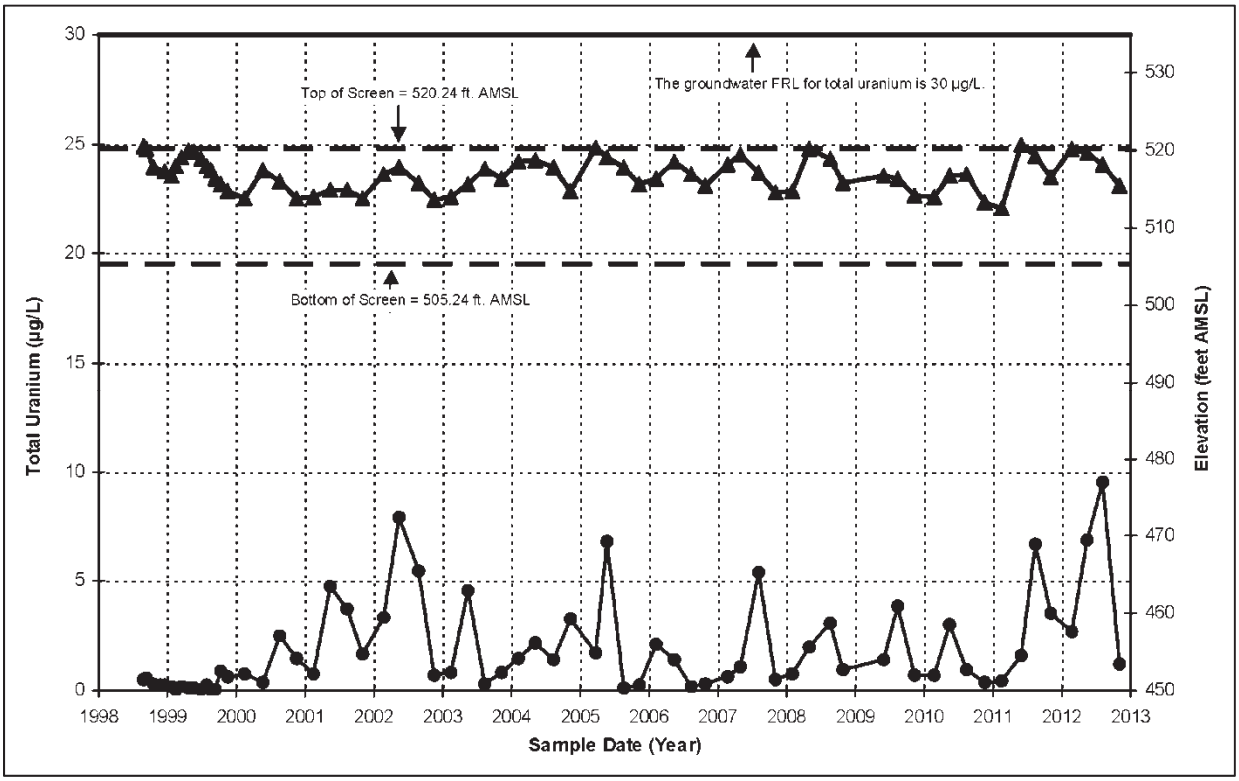


Figure A.5.3–4. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 3 Upgradient Monitoring Well 22203

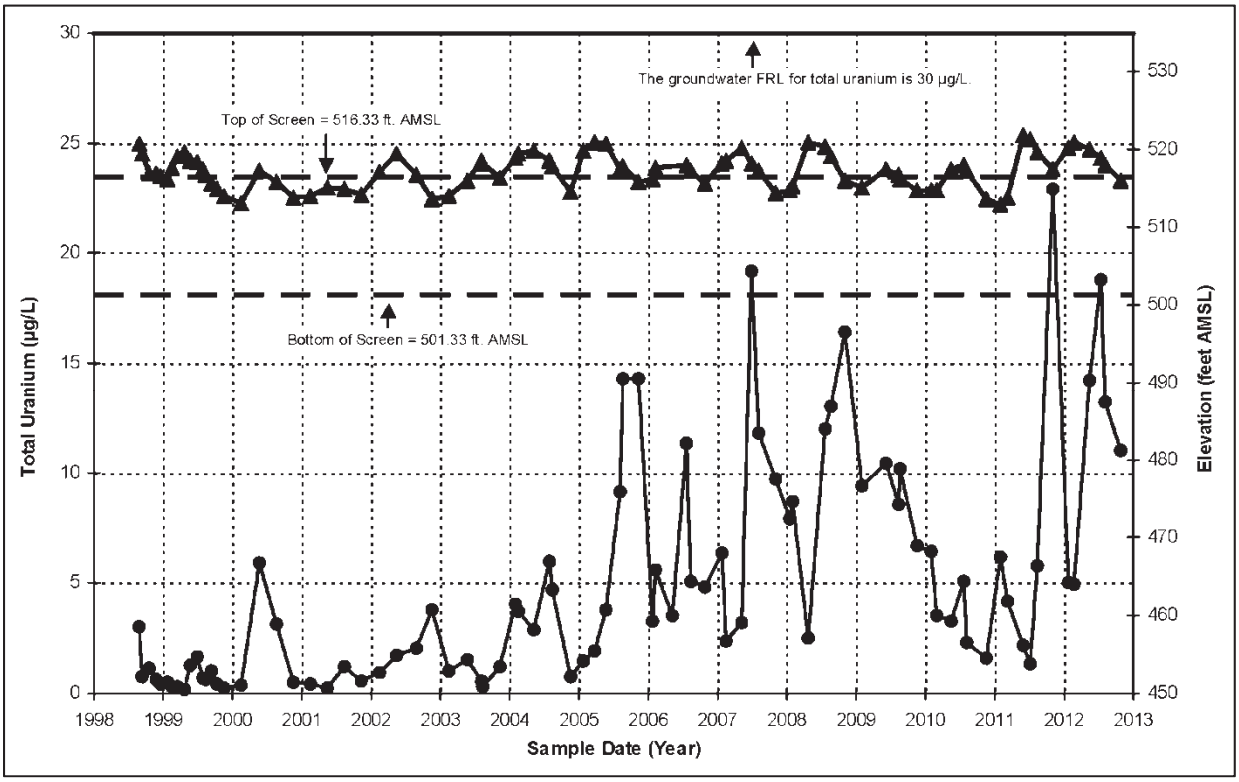


Figure A.5.3–5. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 3 Downgradient Monitoring Well 22204

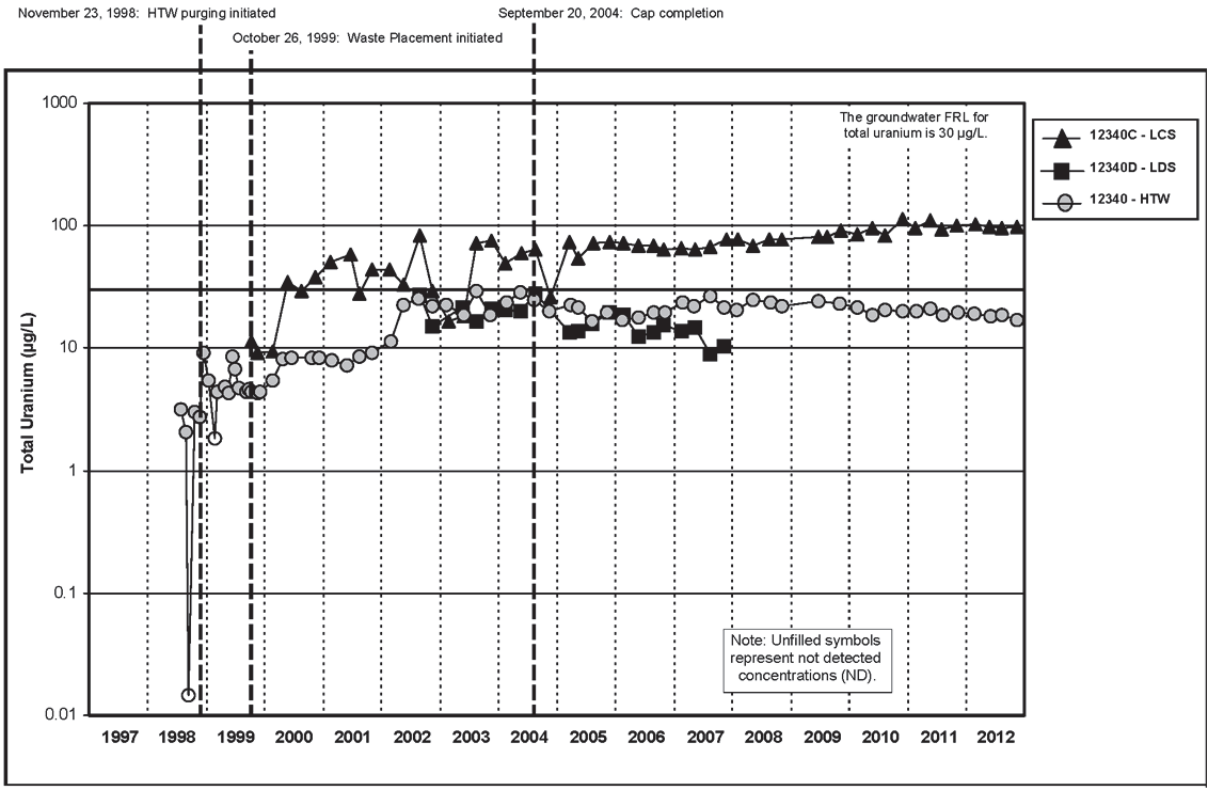


Figure A.5.3–6A. Cell 3 Uranium, Total Concentration vs. Time Plot for LCS, LDS, and HTW

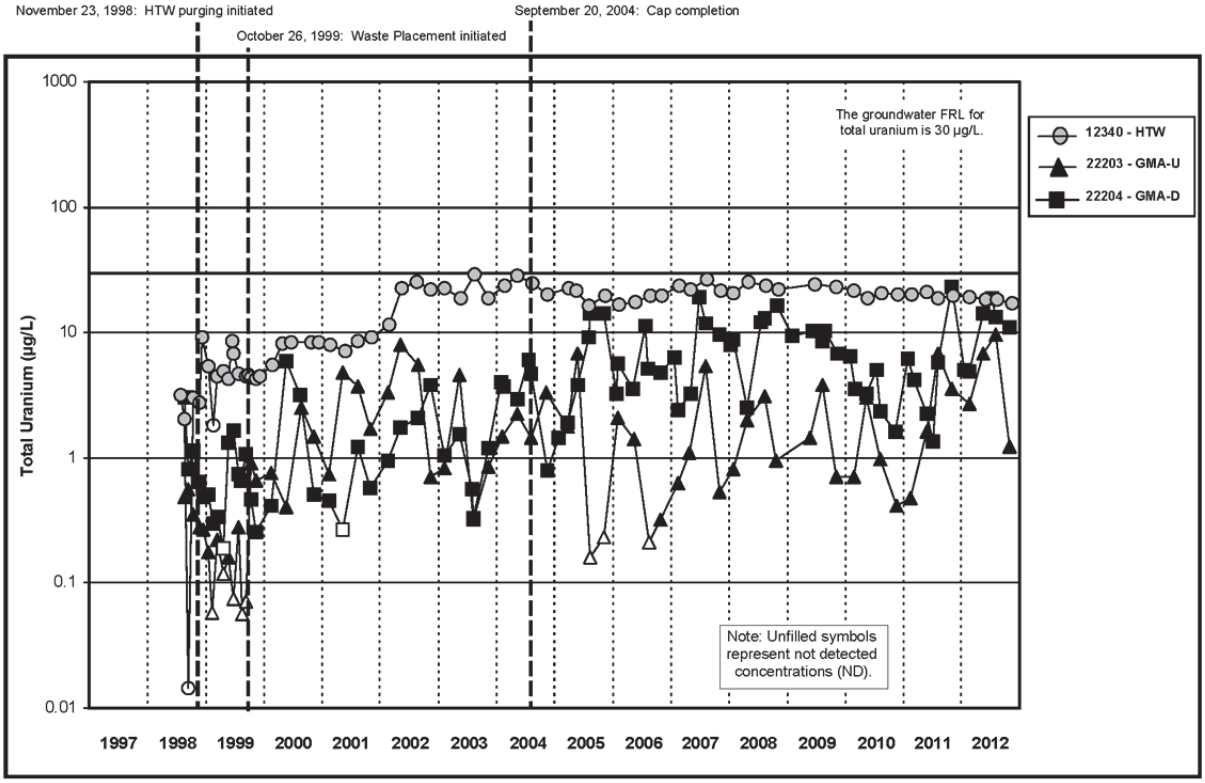


Figure A.5.3–6B. Cell 3 Uranium, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

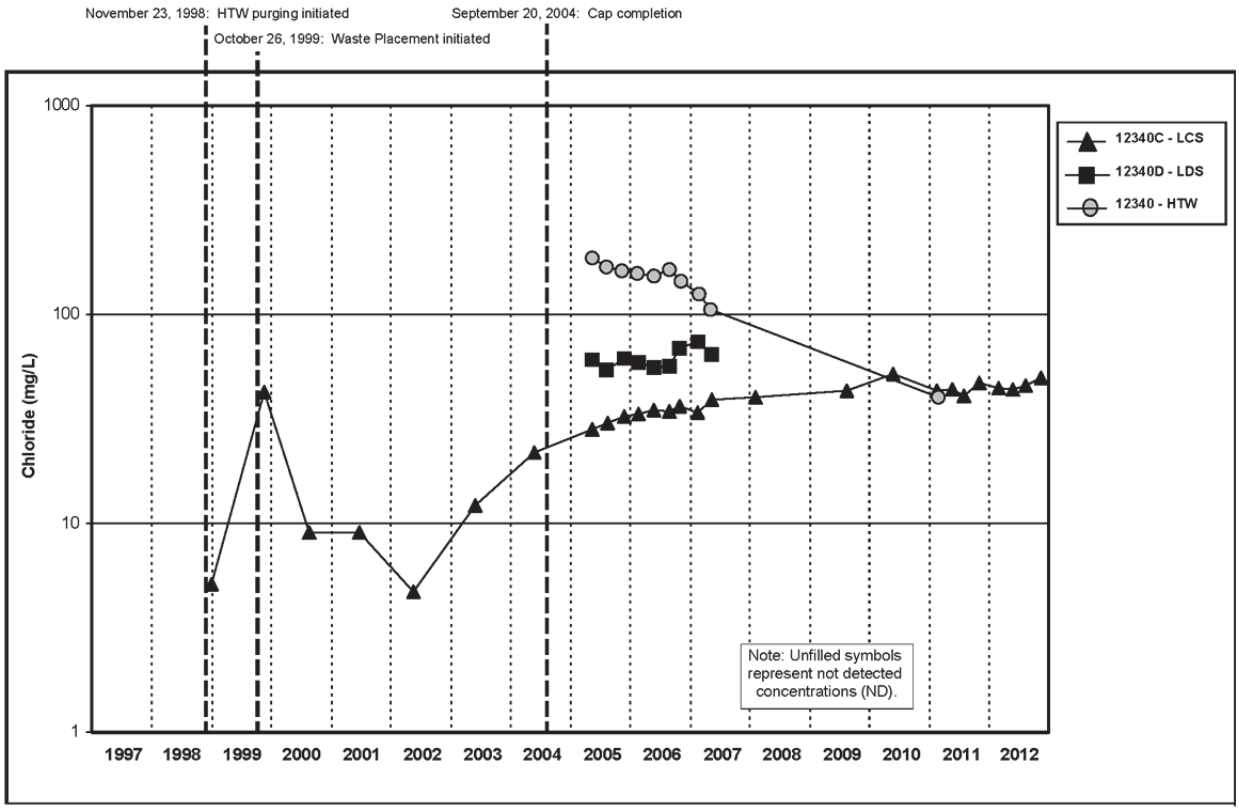


Figure A.5.3–7A. Cell 3 Chloride Concentration vs. Time Plot for LCS, LDS, and HTW

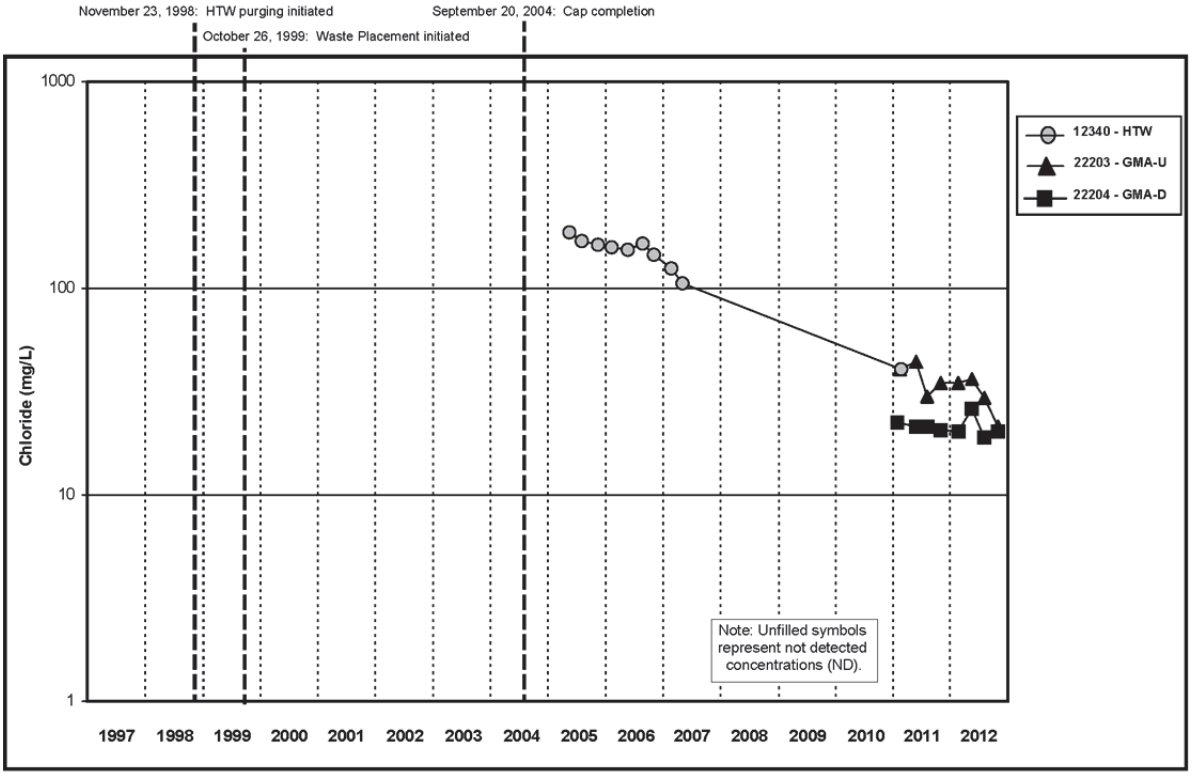


Figure A.5.3–7B. Cell 3 Chloride Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

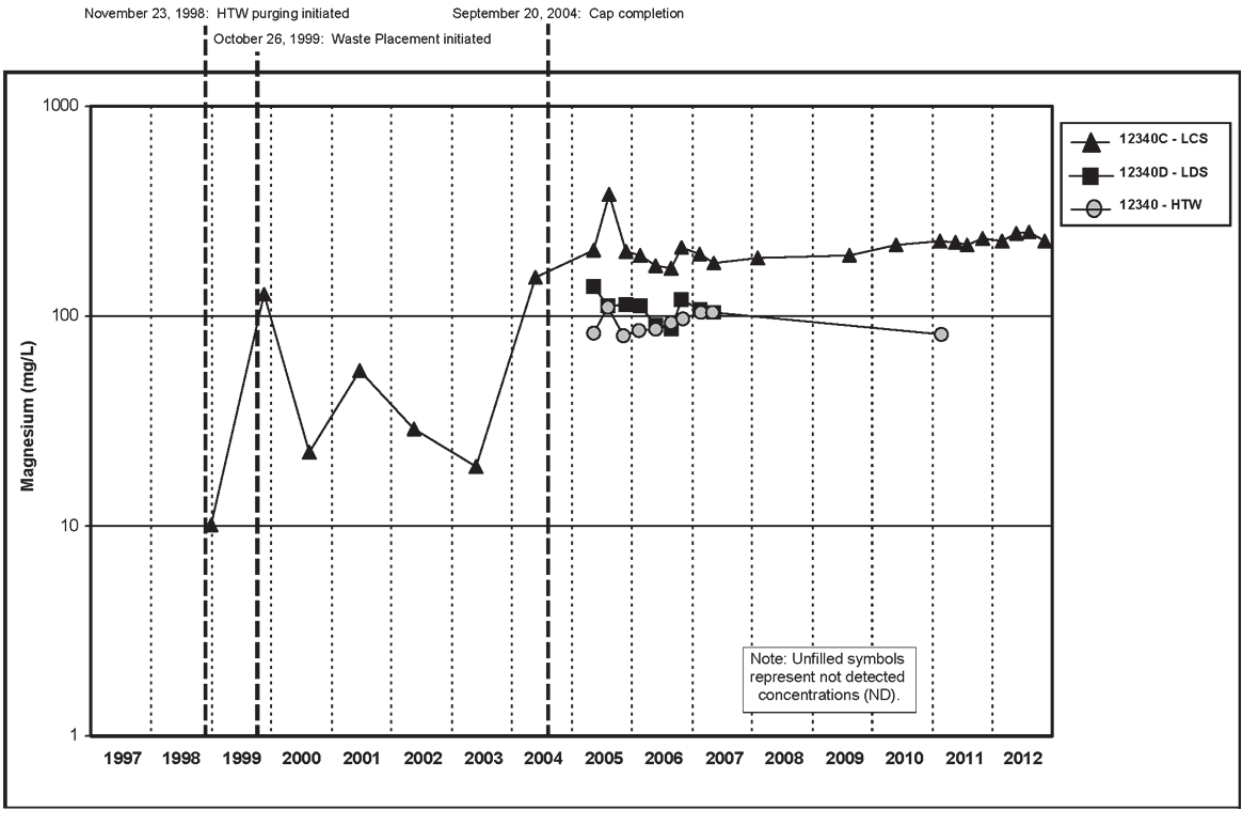


Figure A.5.3–8A. Cell 3 Magnesium Concentration vs. Time Plot for LCS, LDS, and HTW

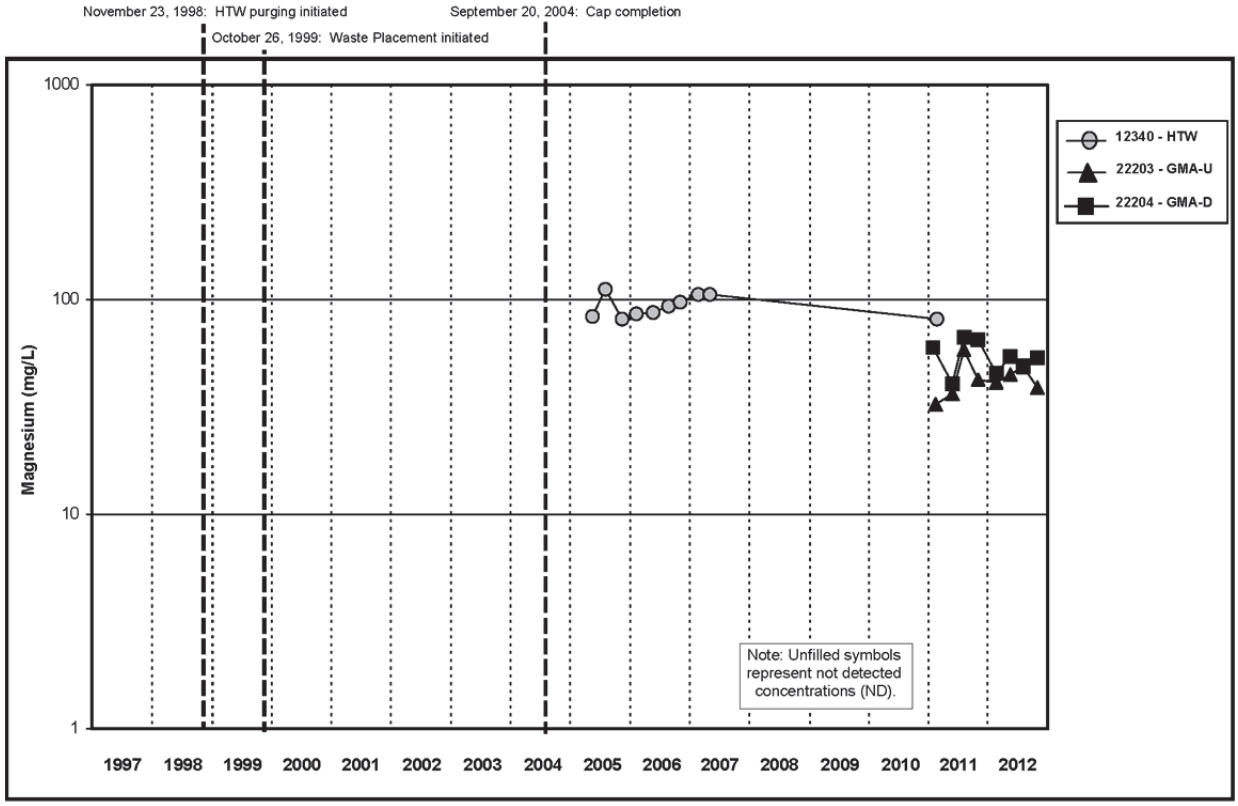


Figure A.5.3–8B. Cell 3 Magnesium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

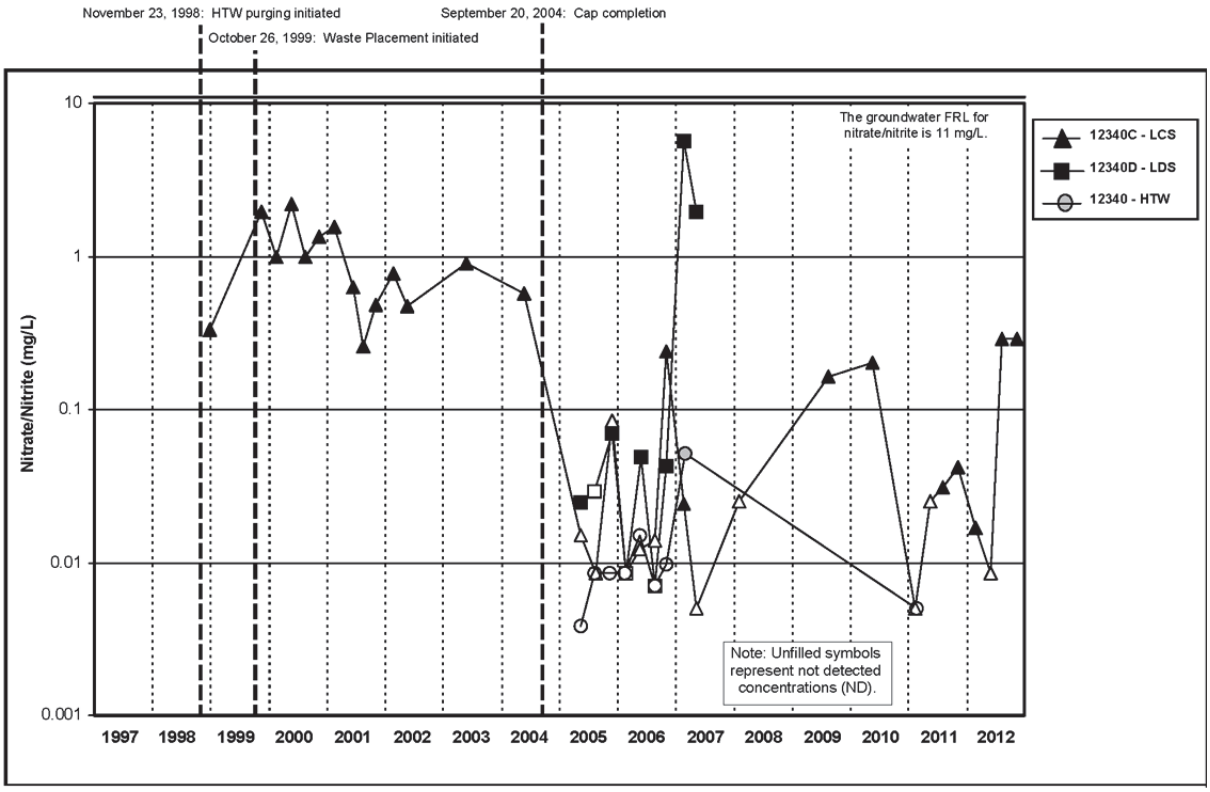


Figure A.5.3–9A. Cell 3 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for LCS, LDS, and HTW

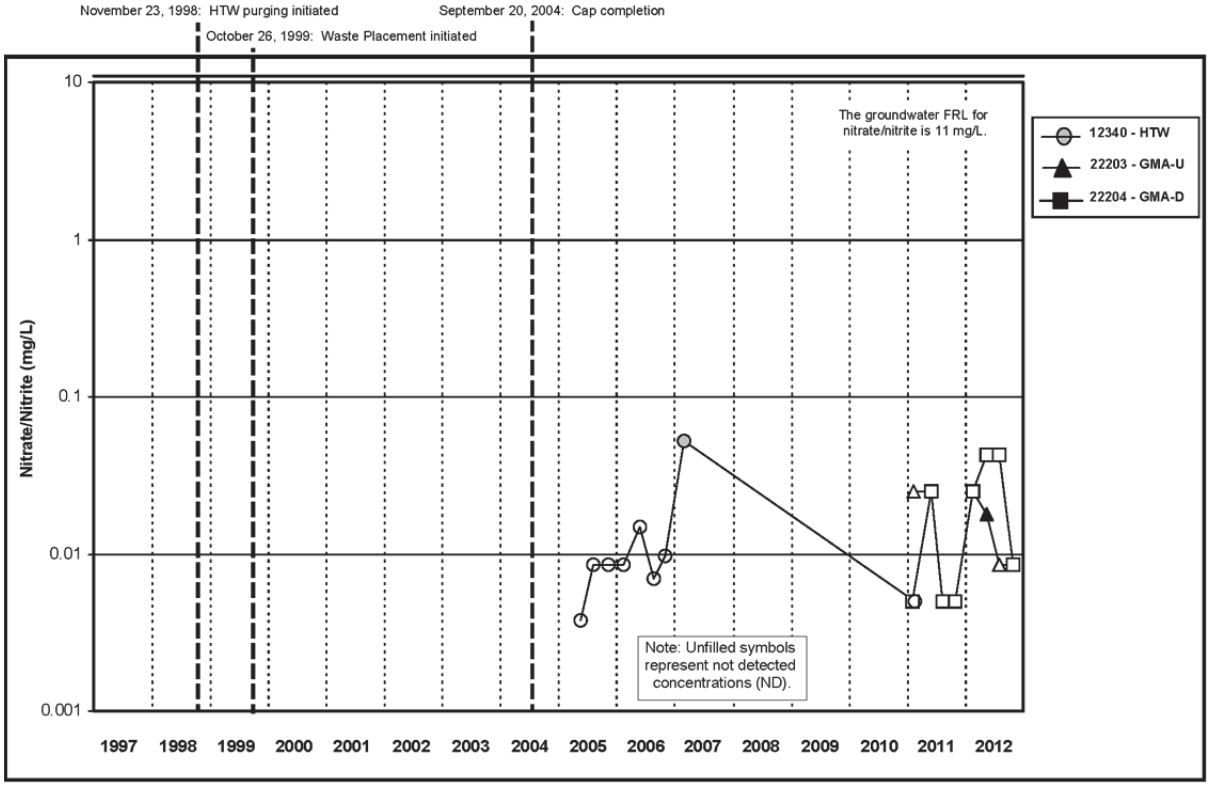


Figure A.5.3–9B. Cell 3 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

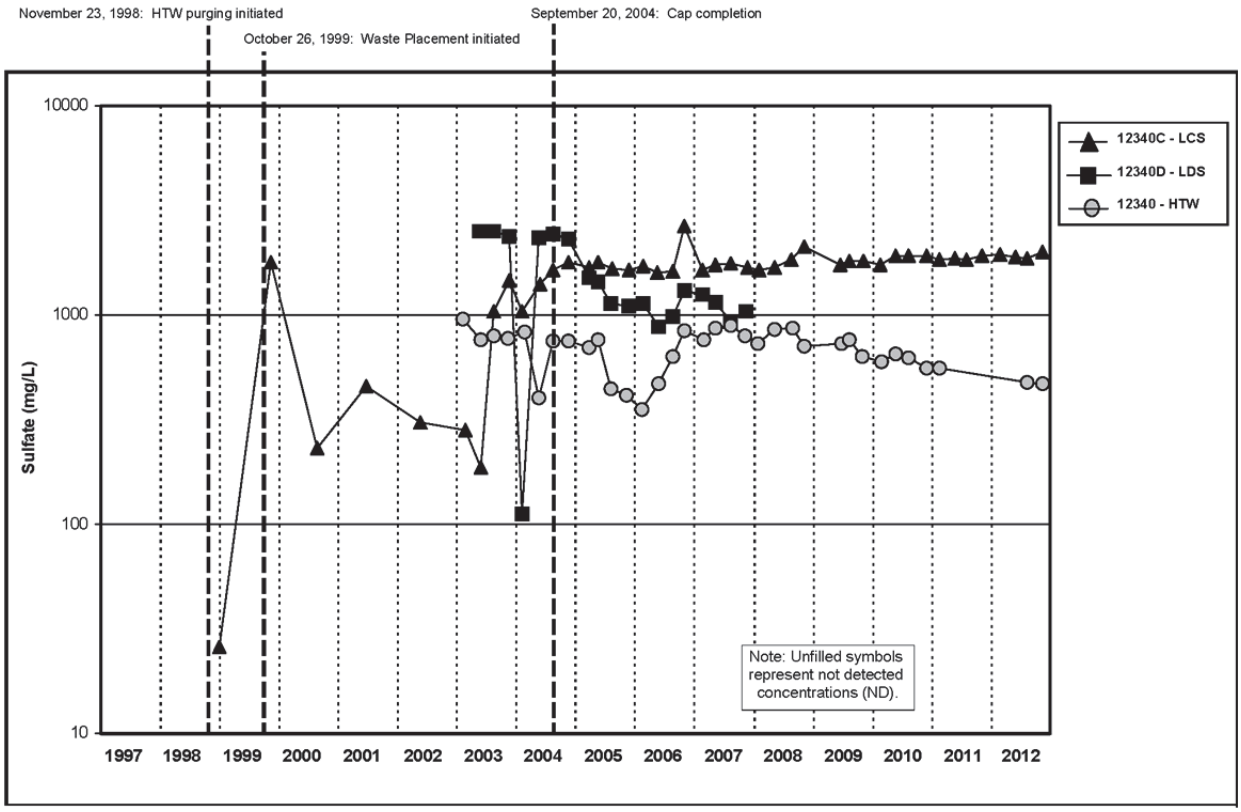


Figure A.5.3–10A. Cell 3 Sulfate Concentration vs. Time Plot for LCS, LDS, and HTW

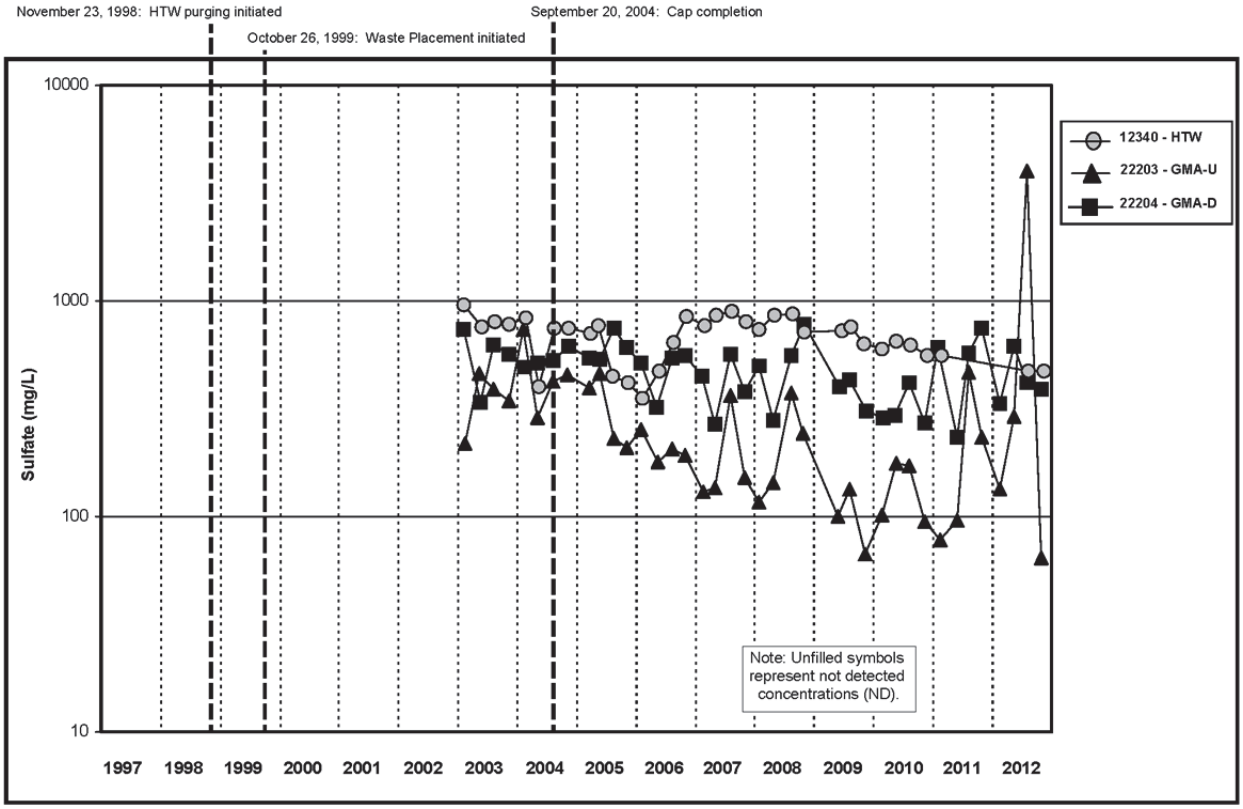


Figure A.5.3–10B. Cell 3 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

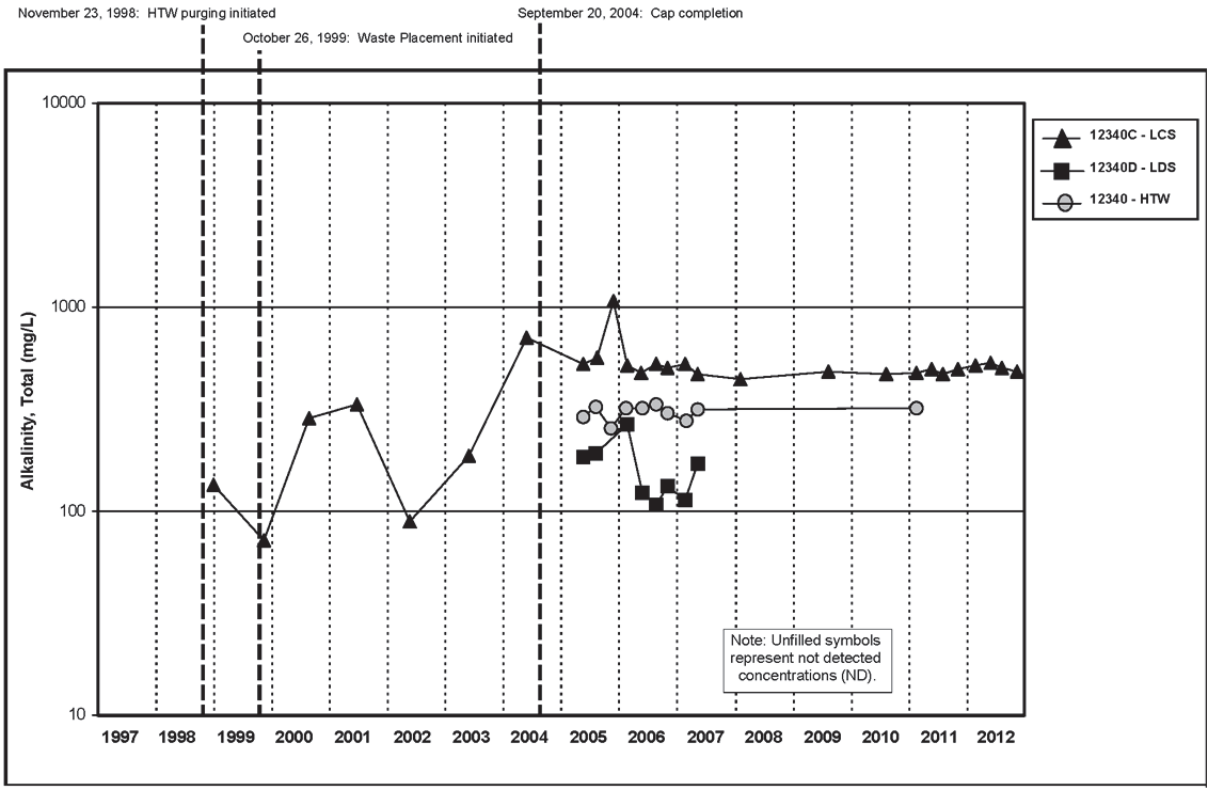


Figure A.5.3–11A. Cell 3 Alkalinity, Total Concentration vs. Time Plot for LCS, LDS, and HTW

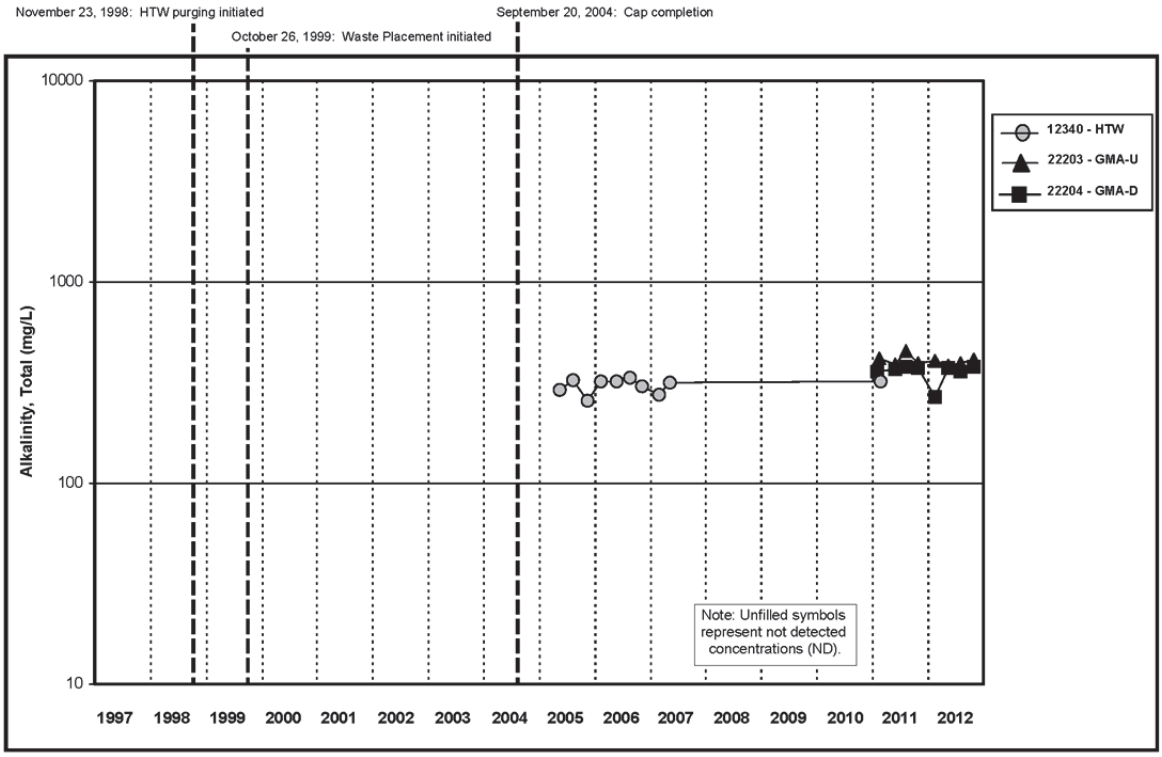


Figure A.5.3–11B. Cell 3 Alkalinity, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

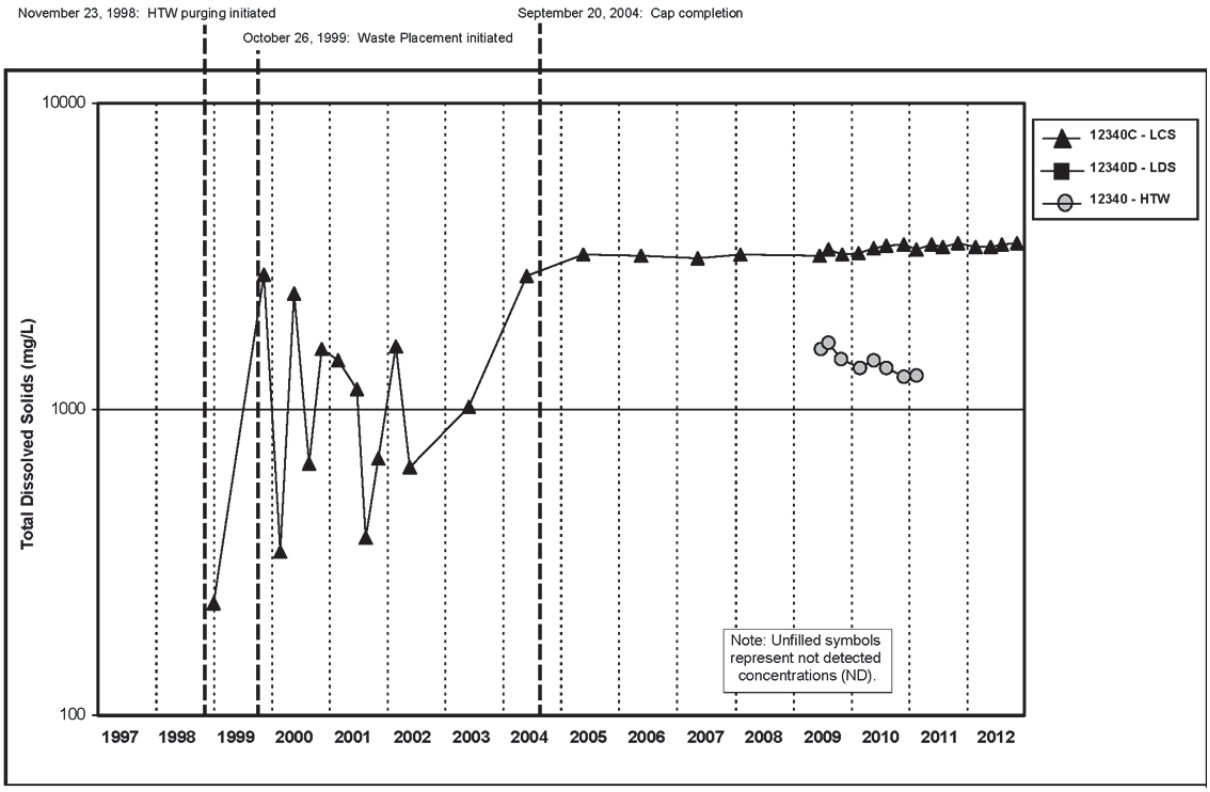


Figure A.5.3–12A. Cell 3 Total Dissolved Solids Concentration vs. Time Plot for LCS, LDS, and HTW

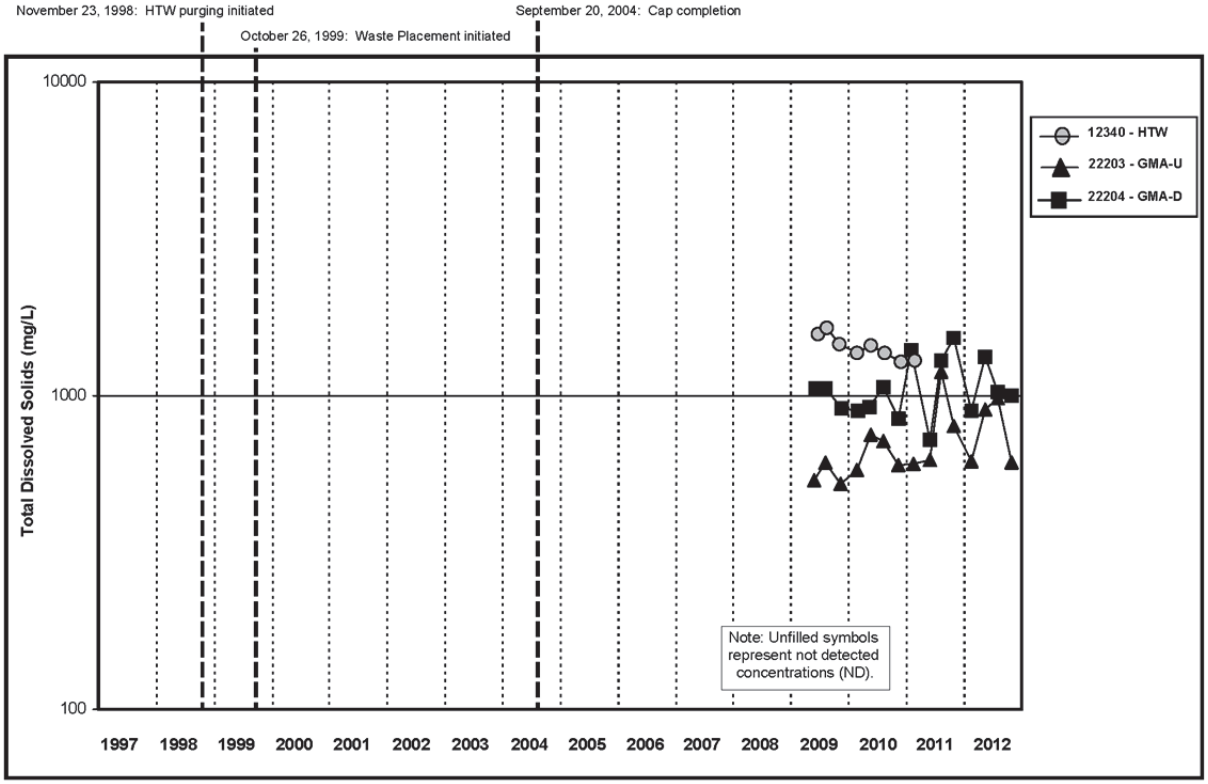


Figure A.5.3–12B. Cell 3 Total Dissolved Solids Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

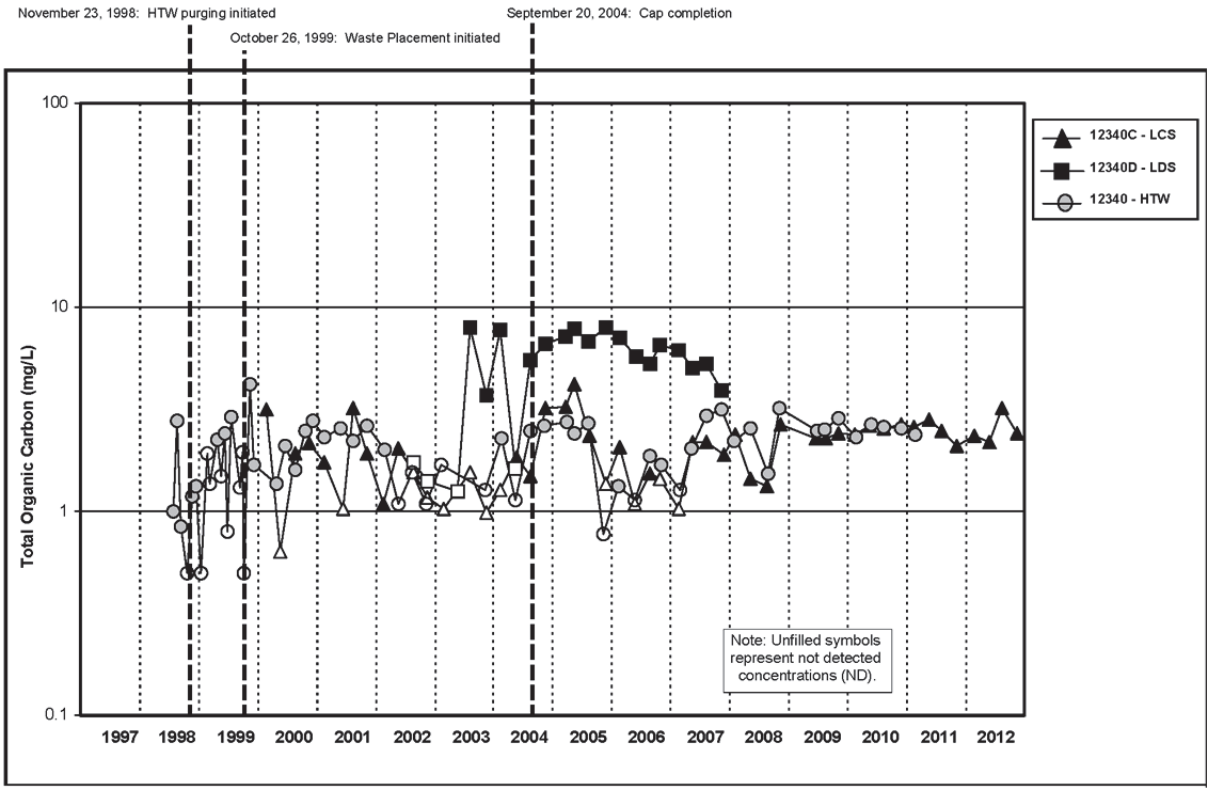


Figure A.5.3–13A. Cell 3 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, and HTW

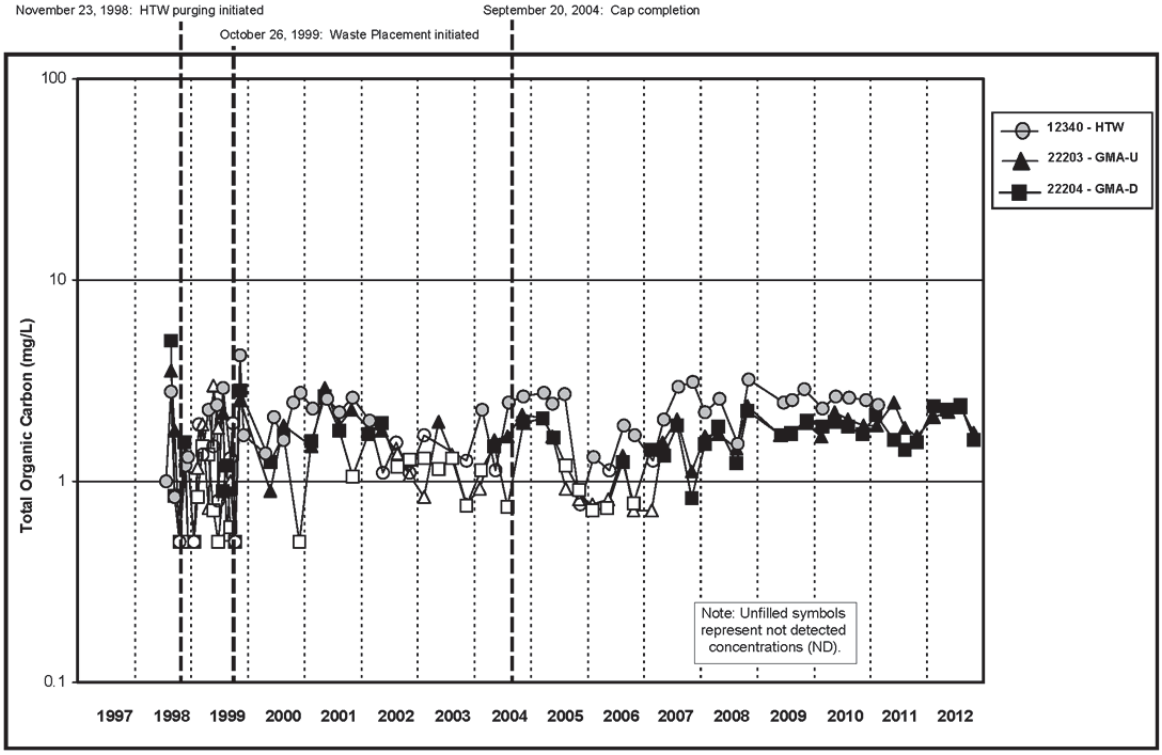


Figure A.5.3–13B. Cell 3 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

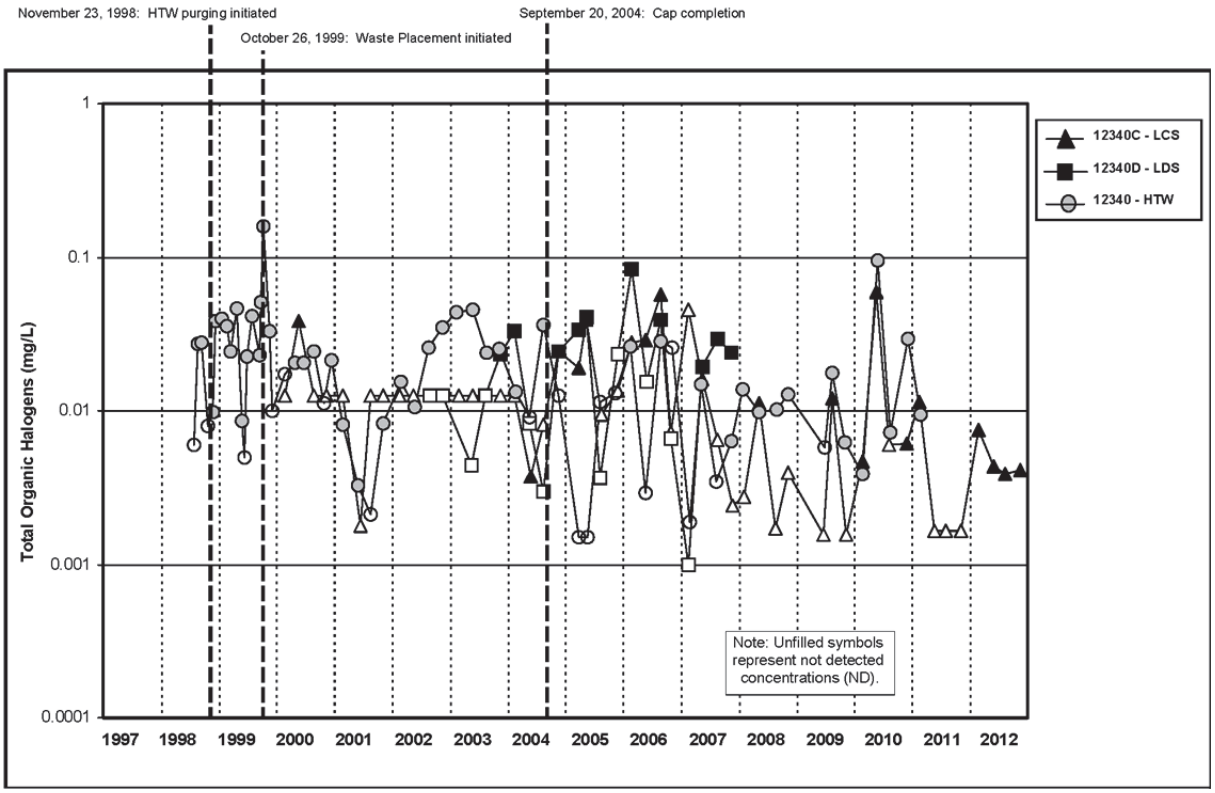


Figure A.5.3–14A. Cell 3 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, and HTW

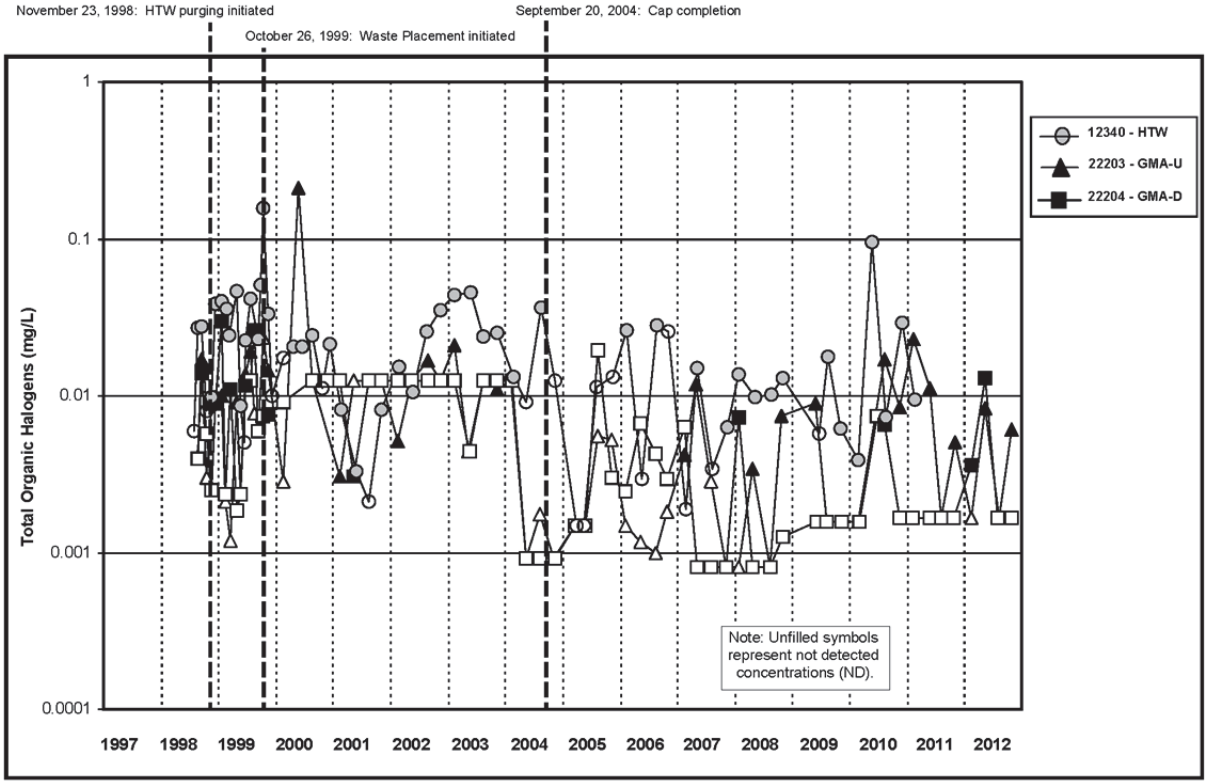


Figure A.5.3–14B. Cell 3 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

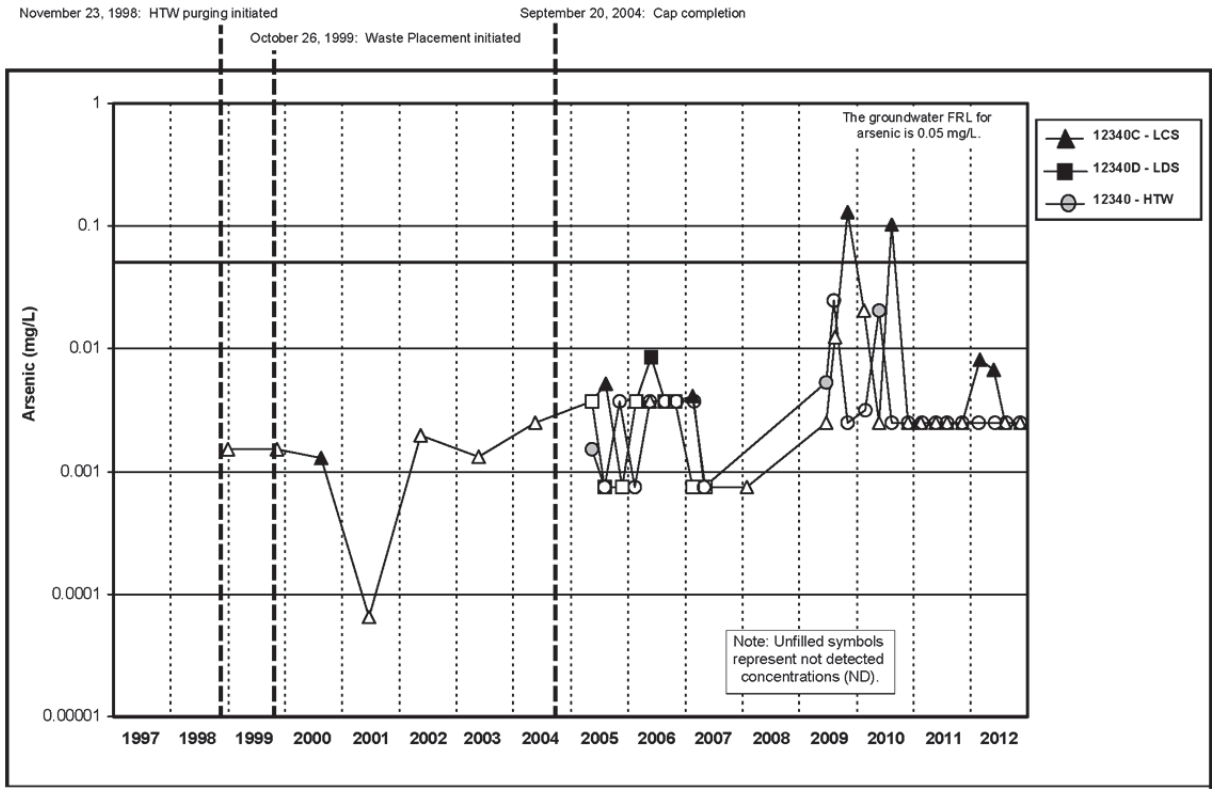


Figure A.5.3–15A. Cell 3 Arsenic Concentration vs. Time Plot for LCS, LDS, and HTW

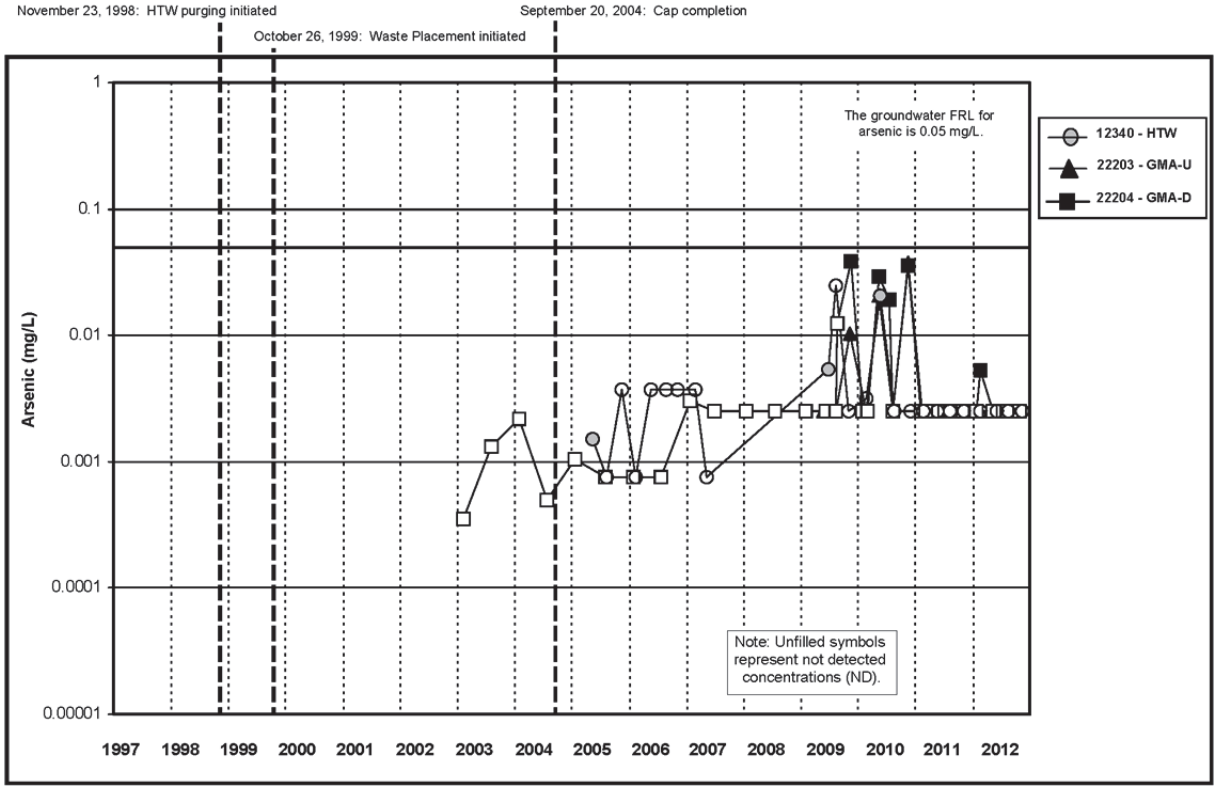


Figure A.5.3–15B. Cell 3 Arsenic Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

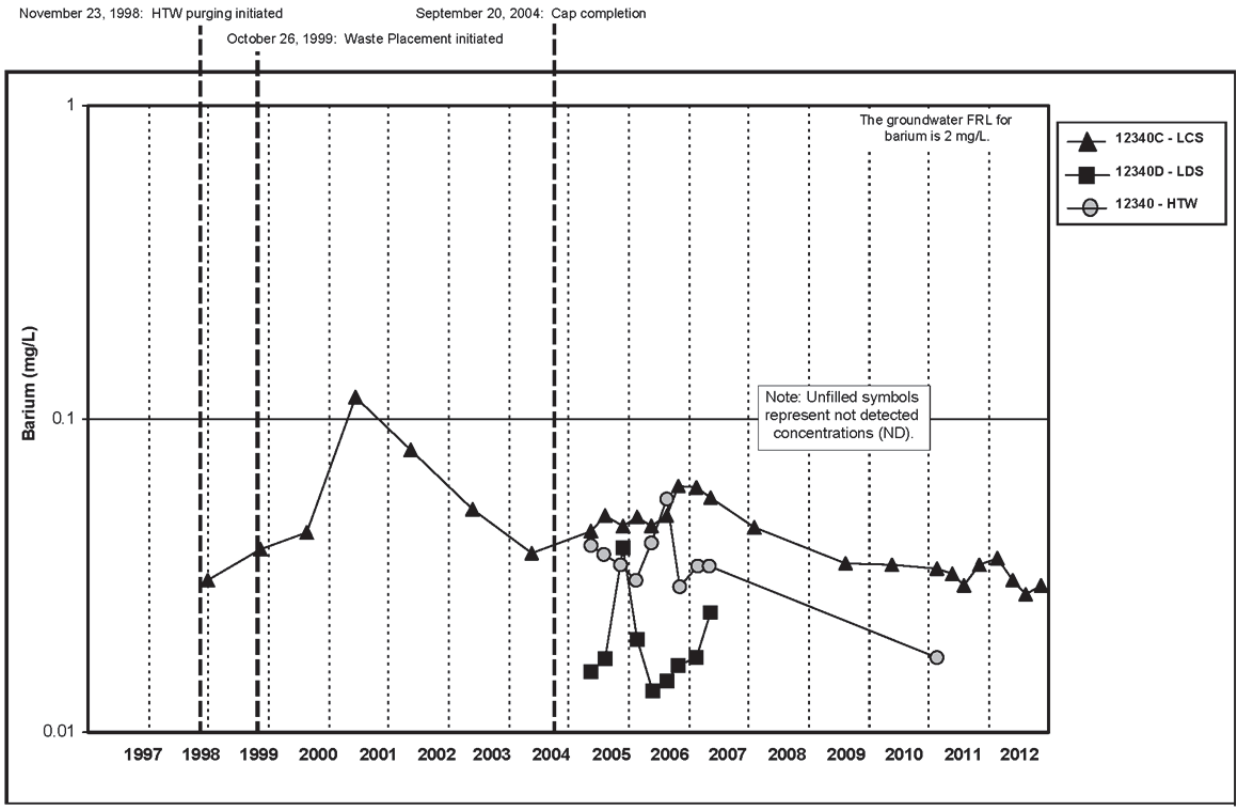


Figure A.5.3–16A. Cell 3 Barium Concentration vs. Time Plot for LCS, LDS, and HTW

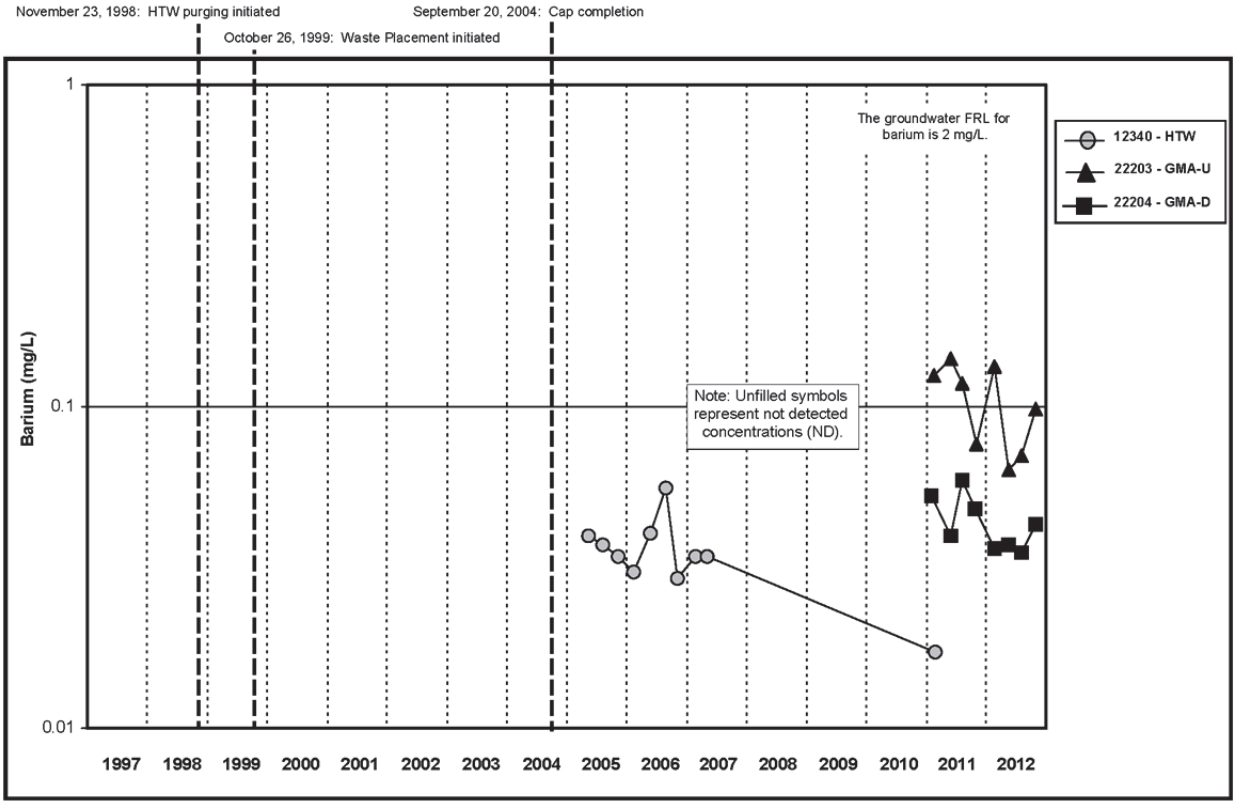


Figure A.5.3–16B. Cell 3 Barium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

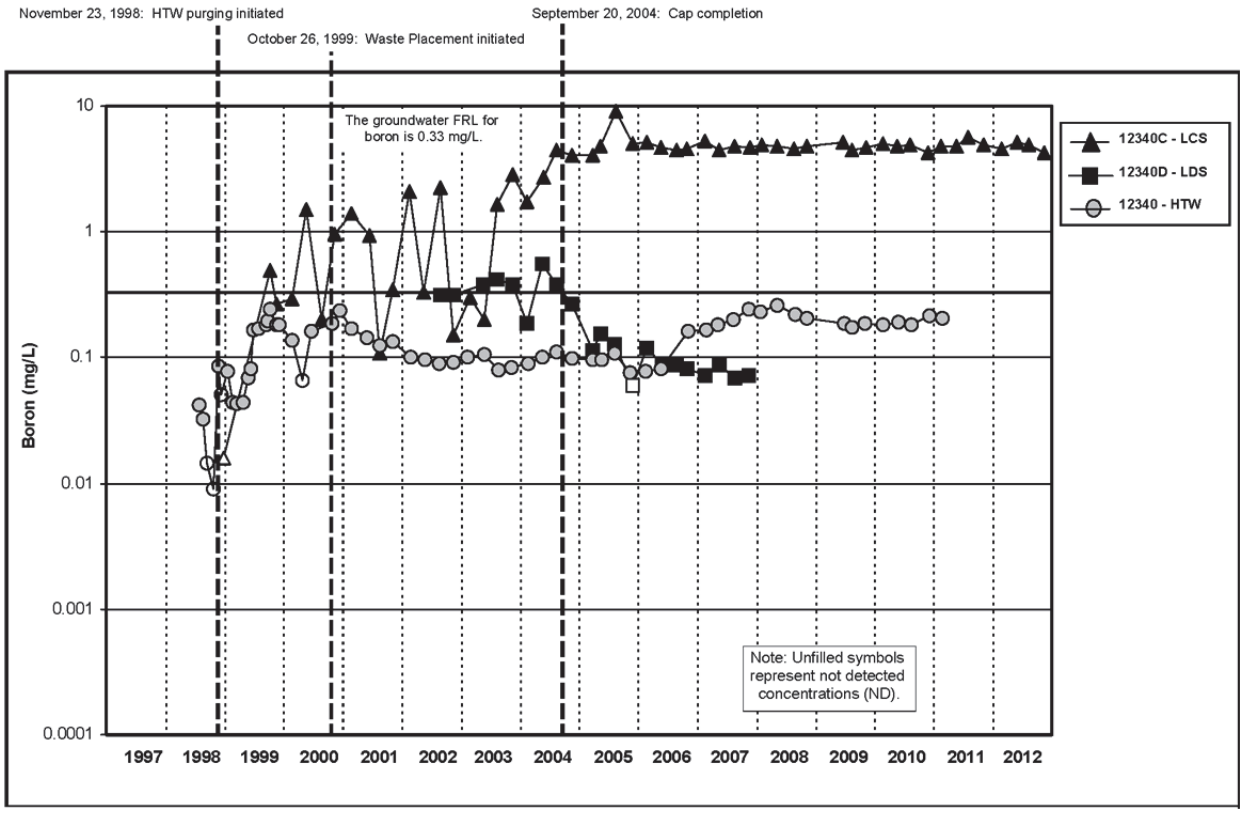


Figure A.5.3–17A. Cell 3 Boron Concentration vs. Time Plot for LCS, LDS, and HTW

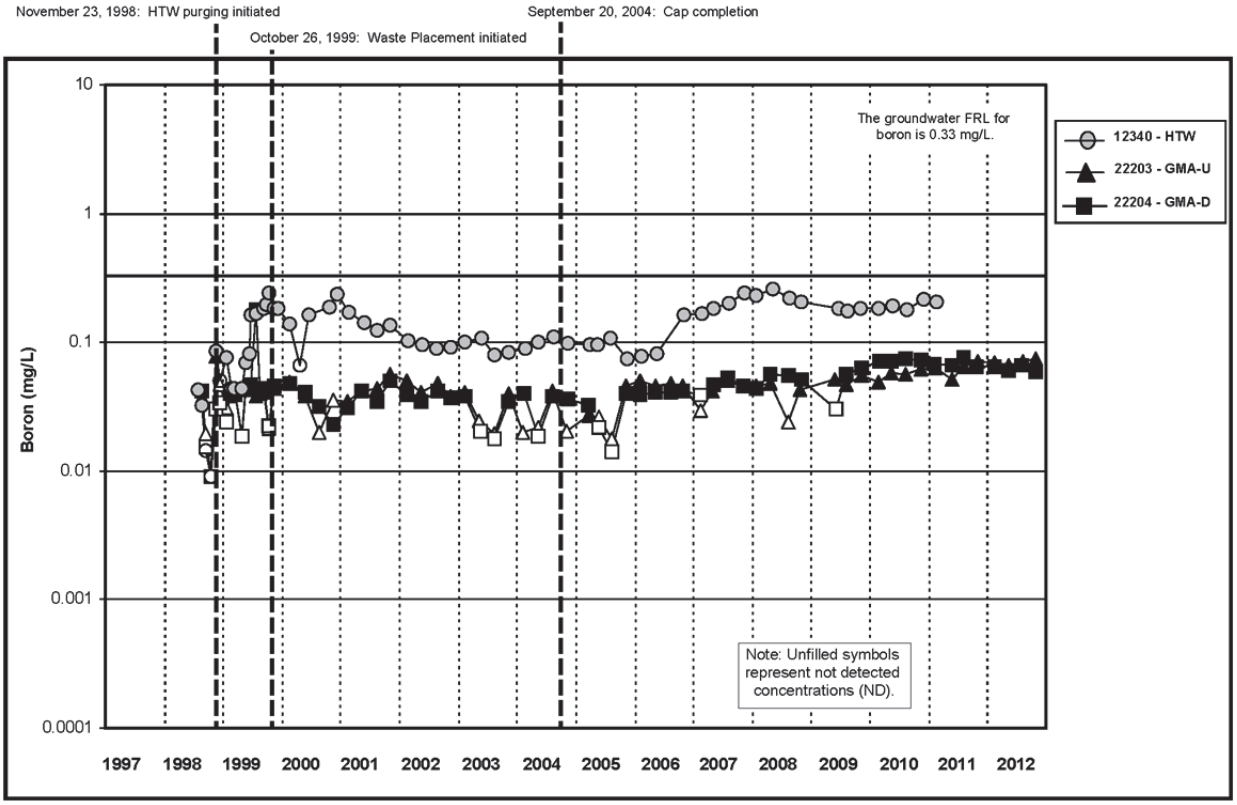


Figure A.5.3–17B. Cell 3 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

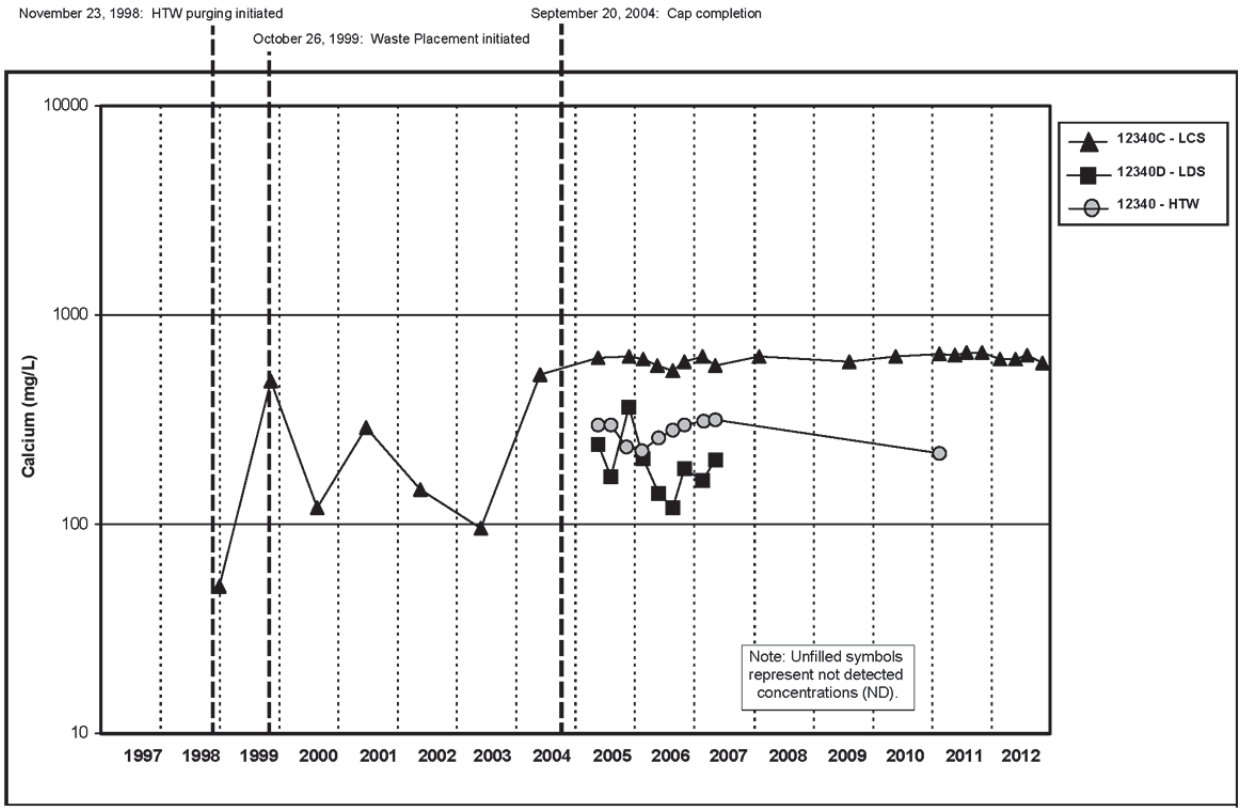


Figure A.5.3–18A. Cell 3 Calcium Concentration vs. Time Plot for LCS, LDS, and HTW

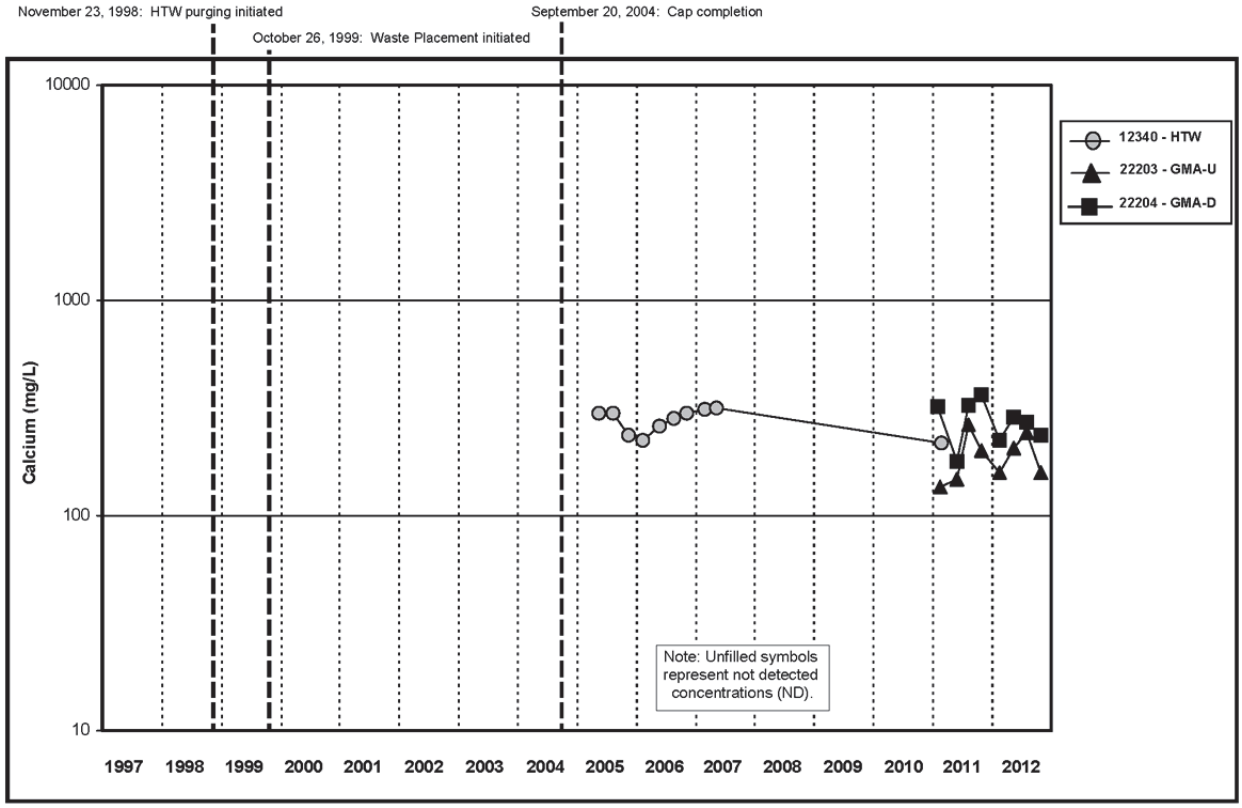


Figure A.5.3–18B. Cell 3 Calcium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

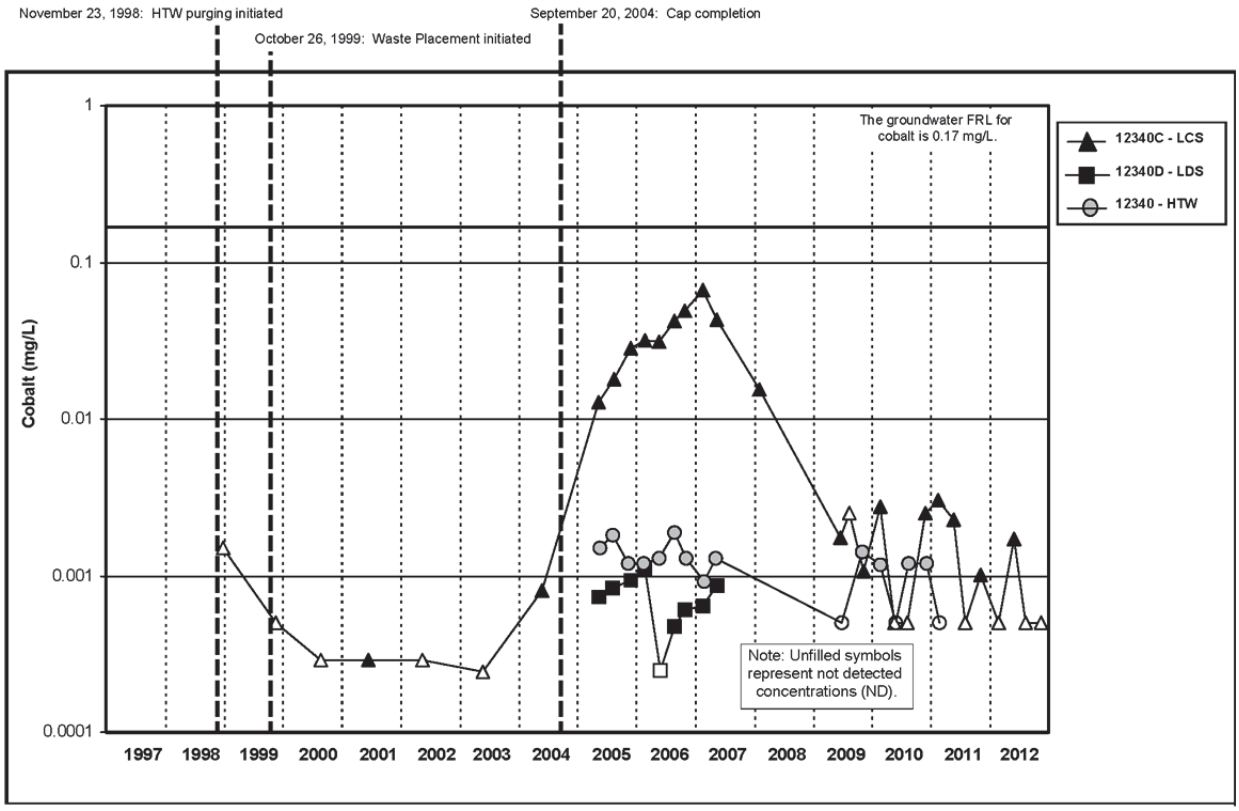


Figure A.5.3–19A. Cell 3 Cobalt Concentration vs. Time Plot for LCS, LDS, and HTW

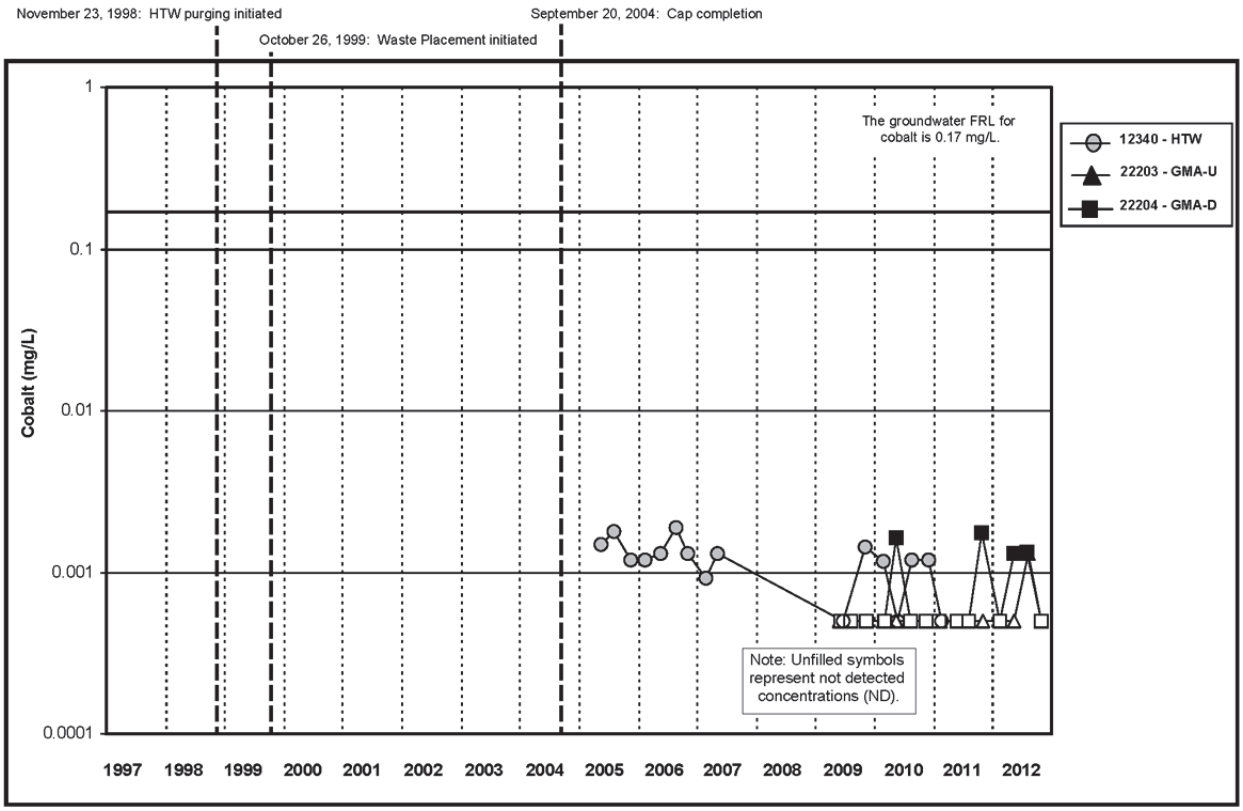


Figure A.5.3–19B. Cell 3 Cobalt Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

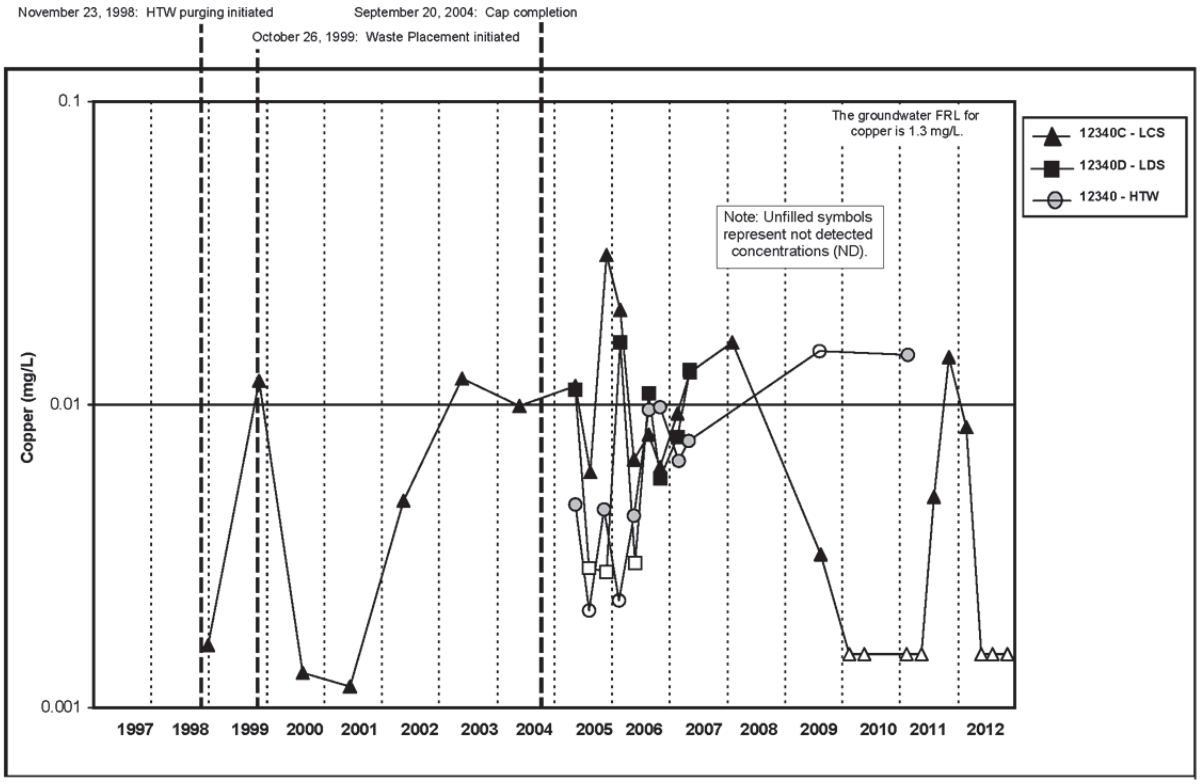


Figure A.5.3–20A. Cell 3 Copper Concentration vs. Time Plot for LCS, LDS, and HTW

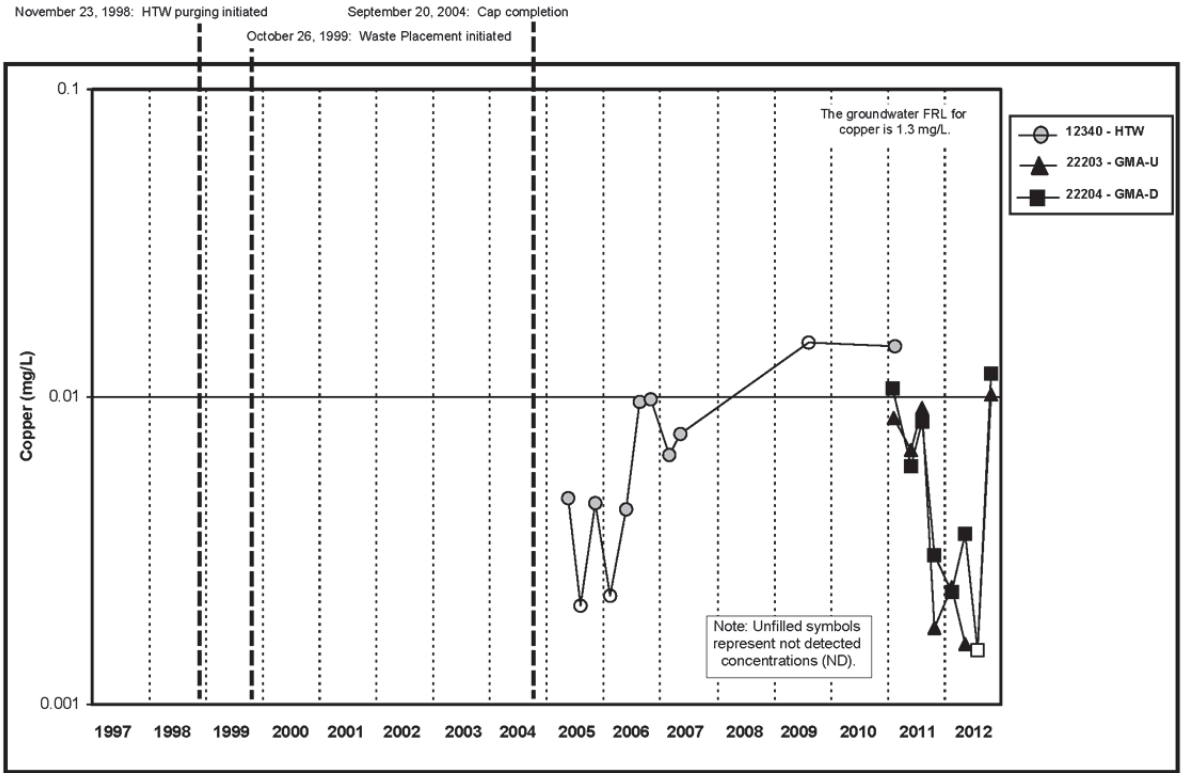


Figure A.5.3–20B. Cell 3 Copper Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

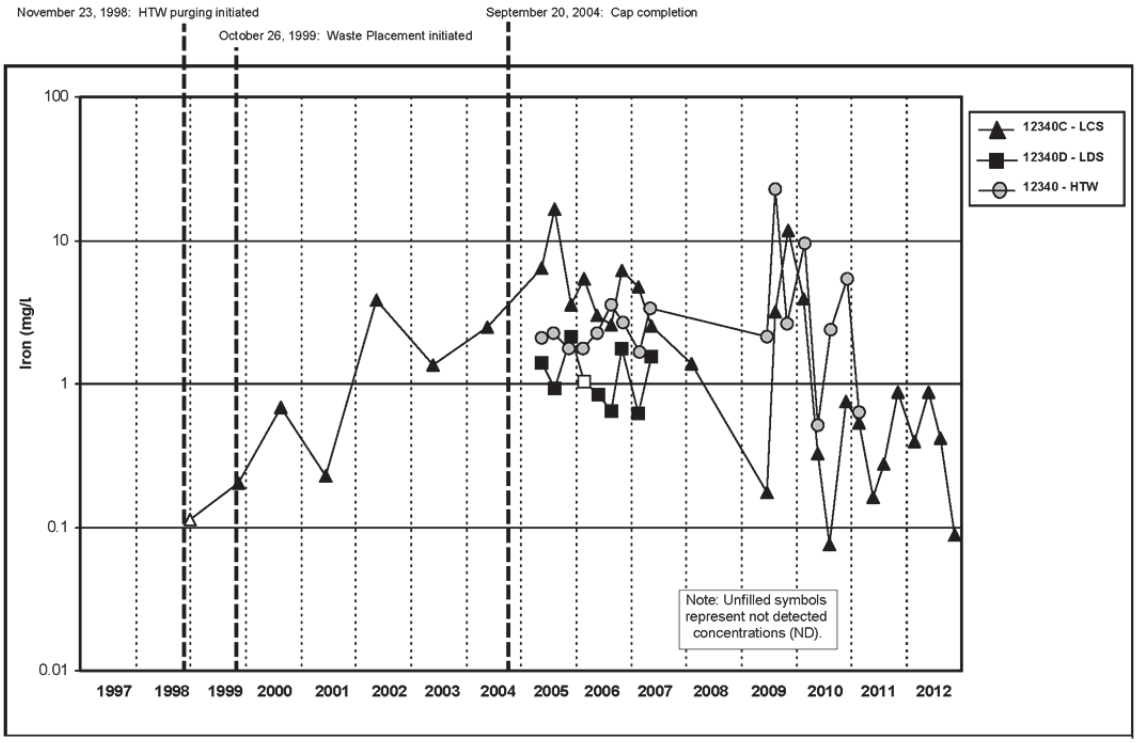


Figure A.5.3–21A. Cell 3 Iron Concentration vs. Time Plot for LCS, LDS, and HTW

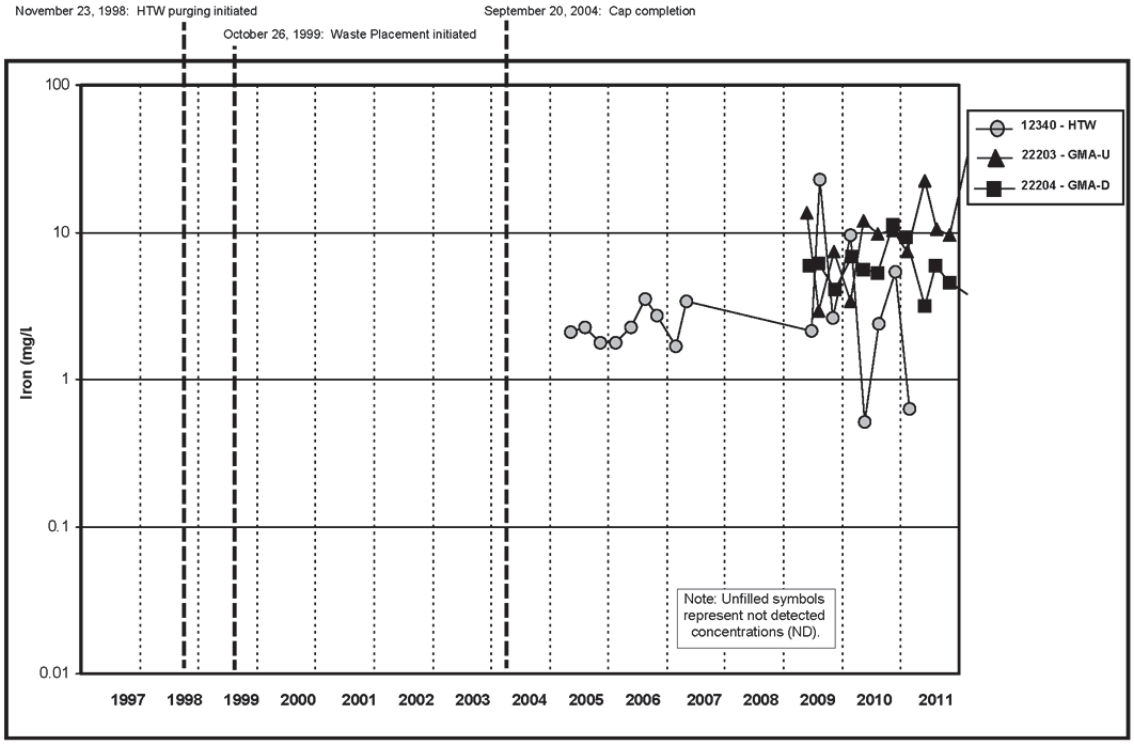


Figure A.5.3–21B. Cell 3 Iron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

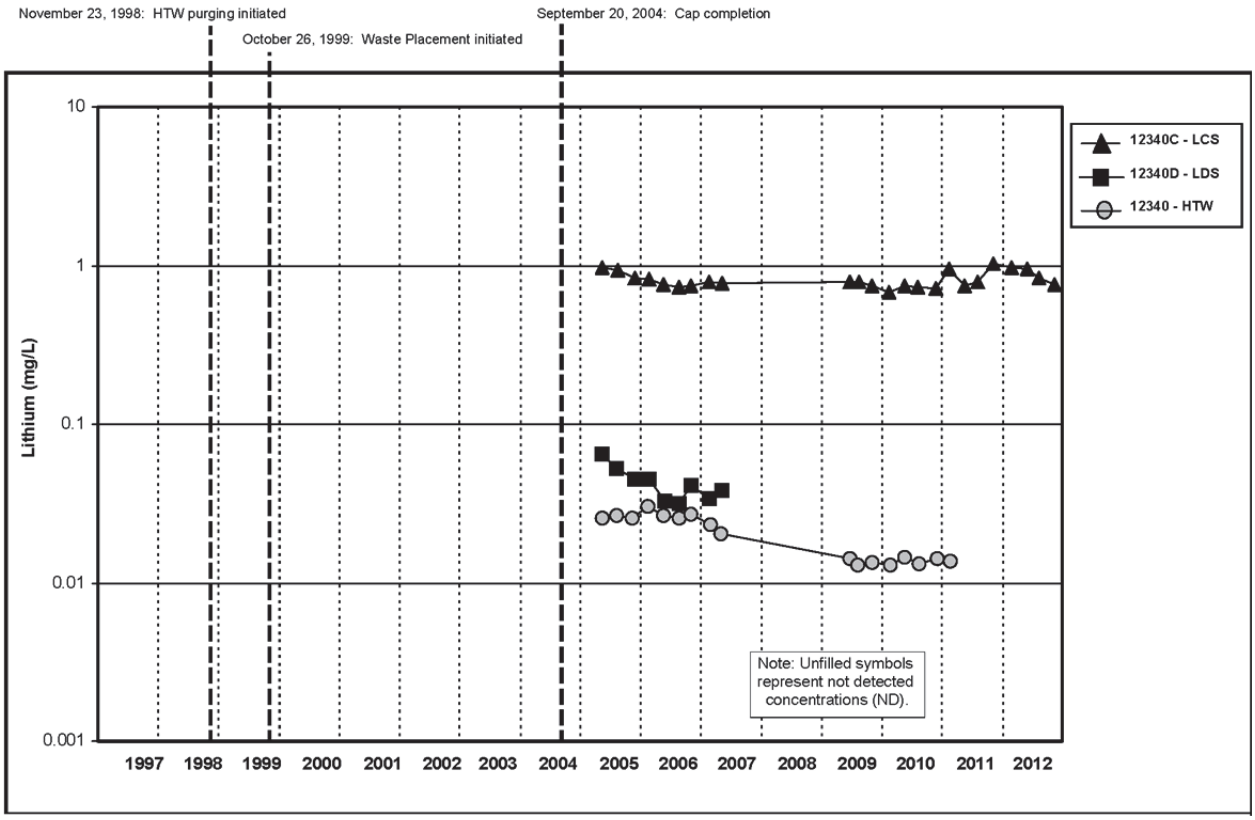


Figure A.5.3–22A. Cell 3 Lithium Concentration vs. Time Plot for LCS, LDS, and HTW

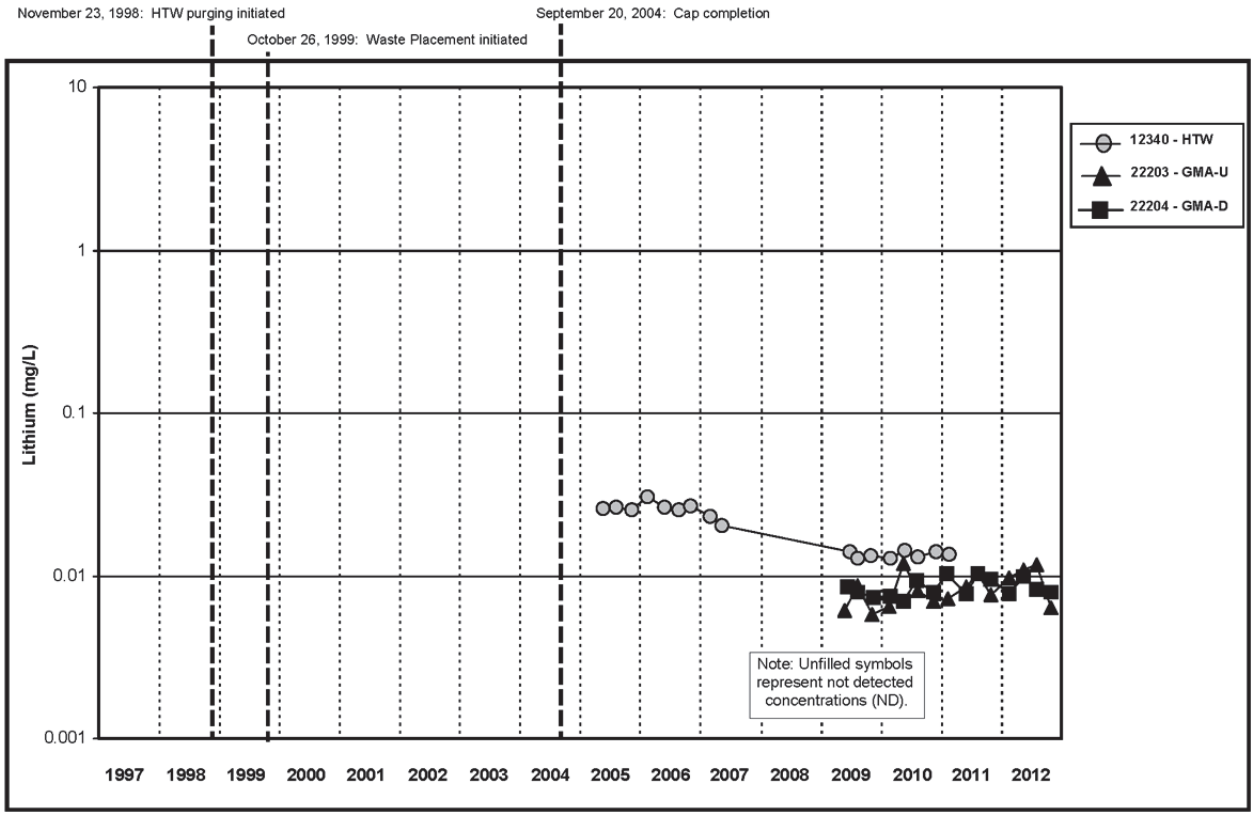


Figure A.5.3–22B. Cell 3 Lithium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

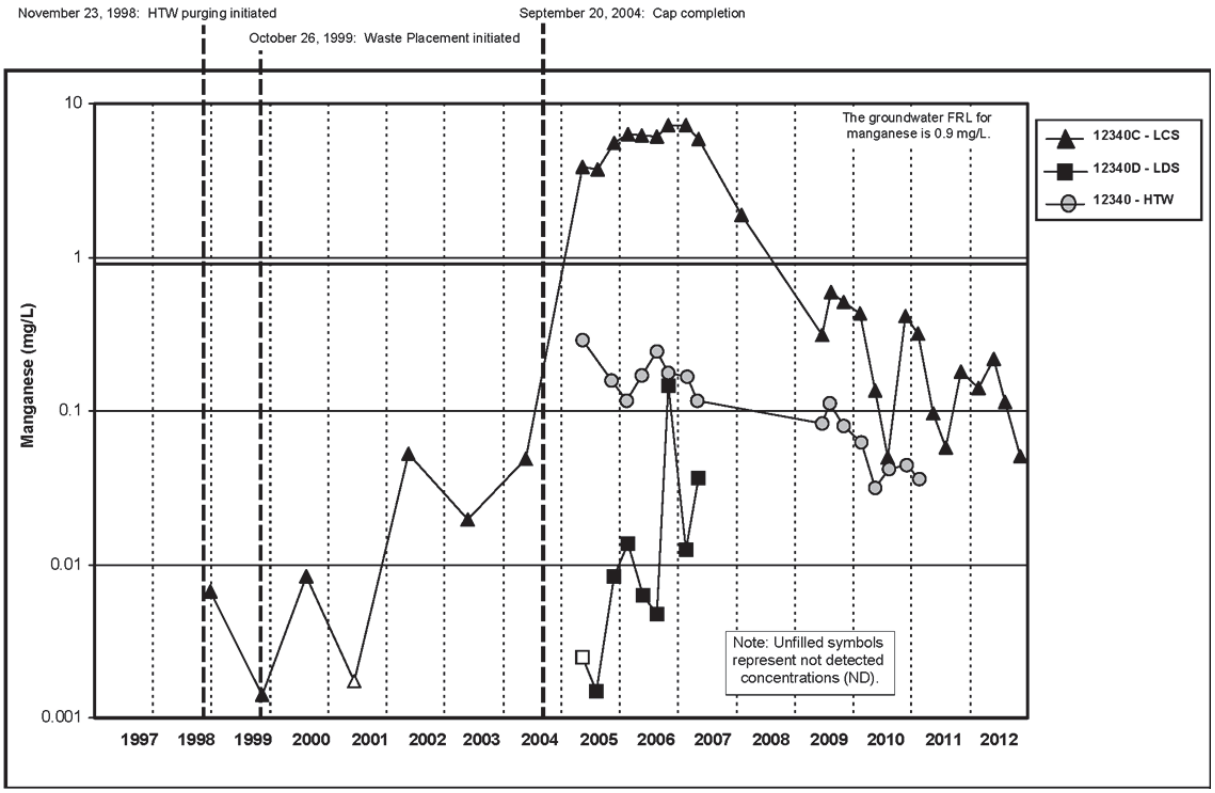


Figure A.5.3–23A. Cell 3 Manganese Concentration vs. Time Plot for LCS, LDS, and HTW

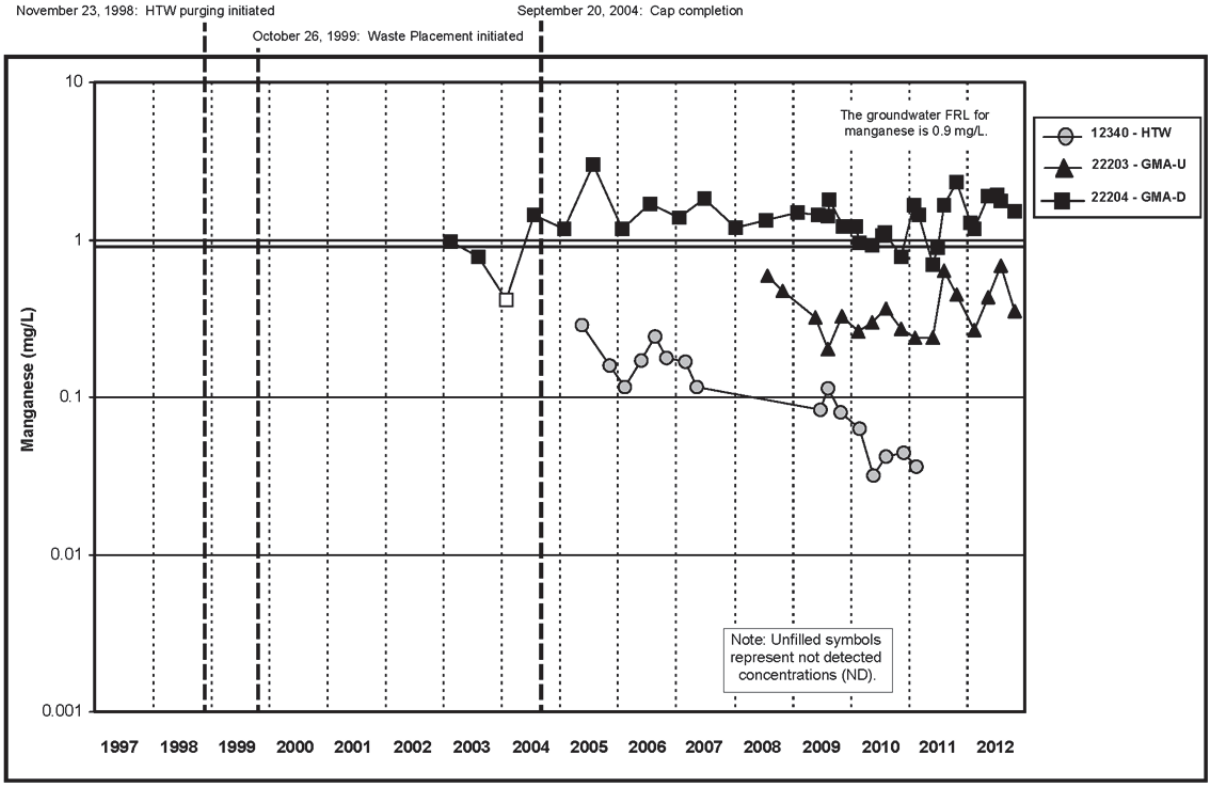
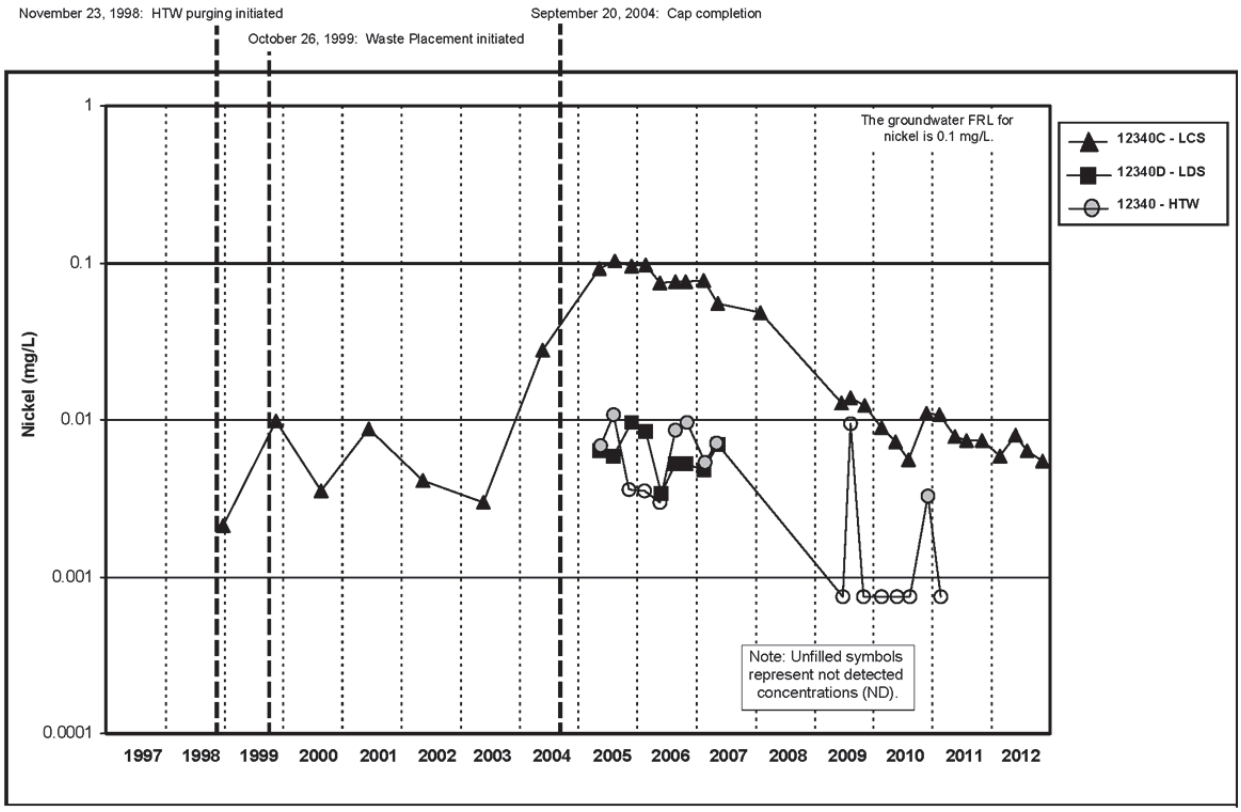


Figure A.5.3–23B. Cell 3 Manganese Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well



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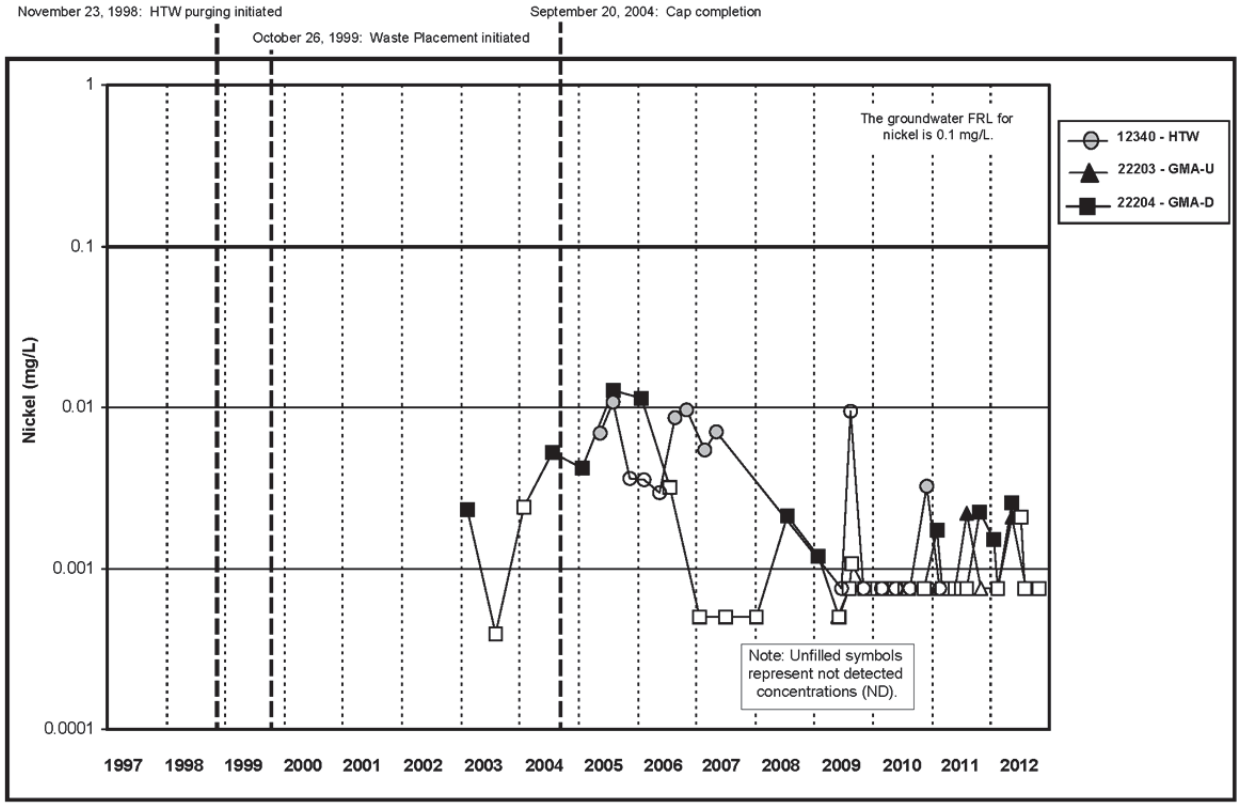
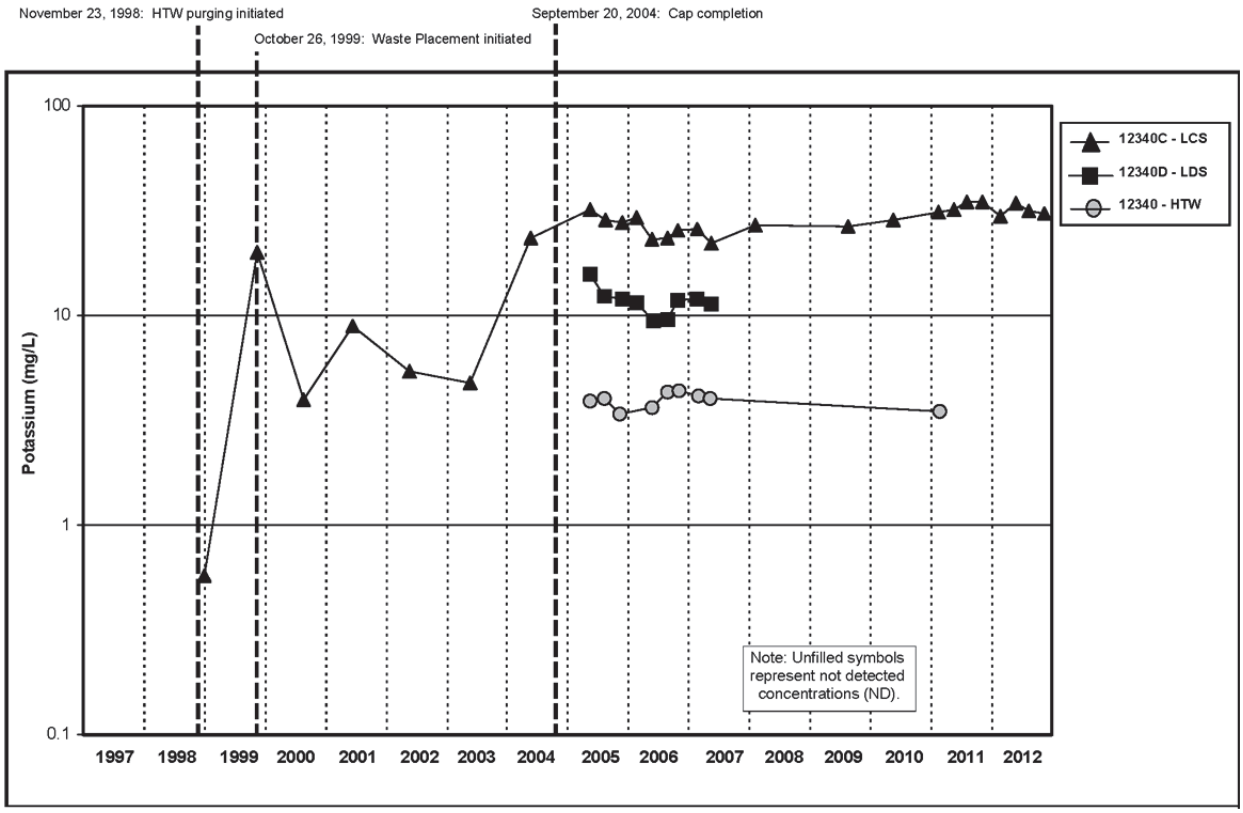


Figure A.5.3–24B. Cell 3 Nickel Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well



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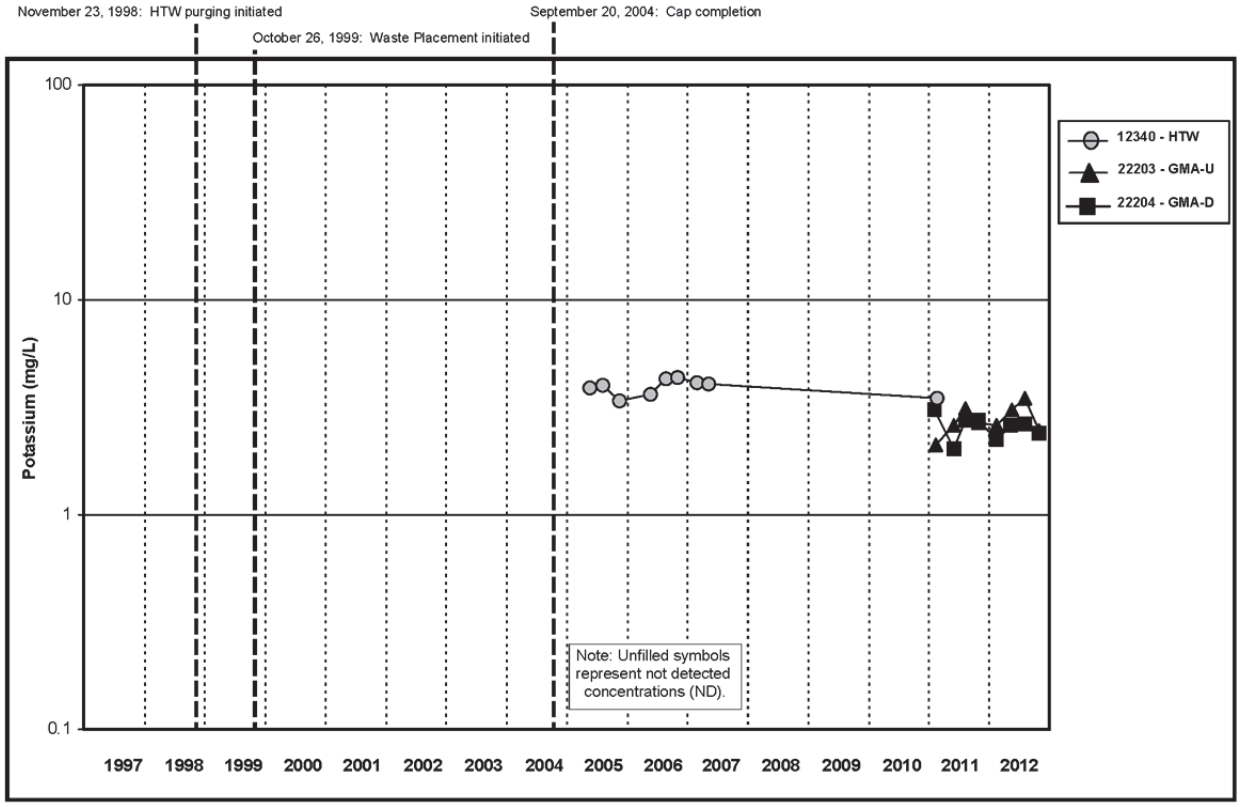


Figure A.5.3–25B. Cell 3 Potassium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

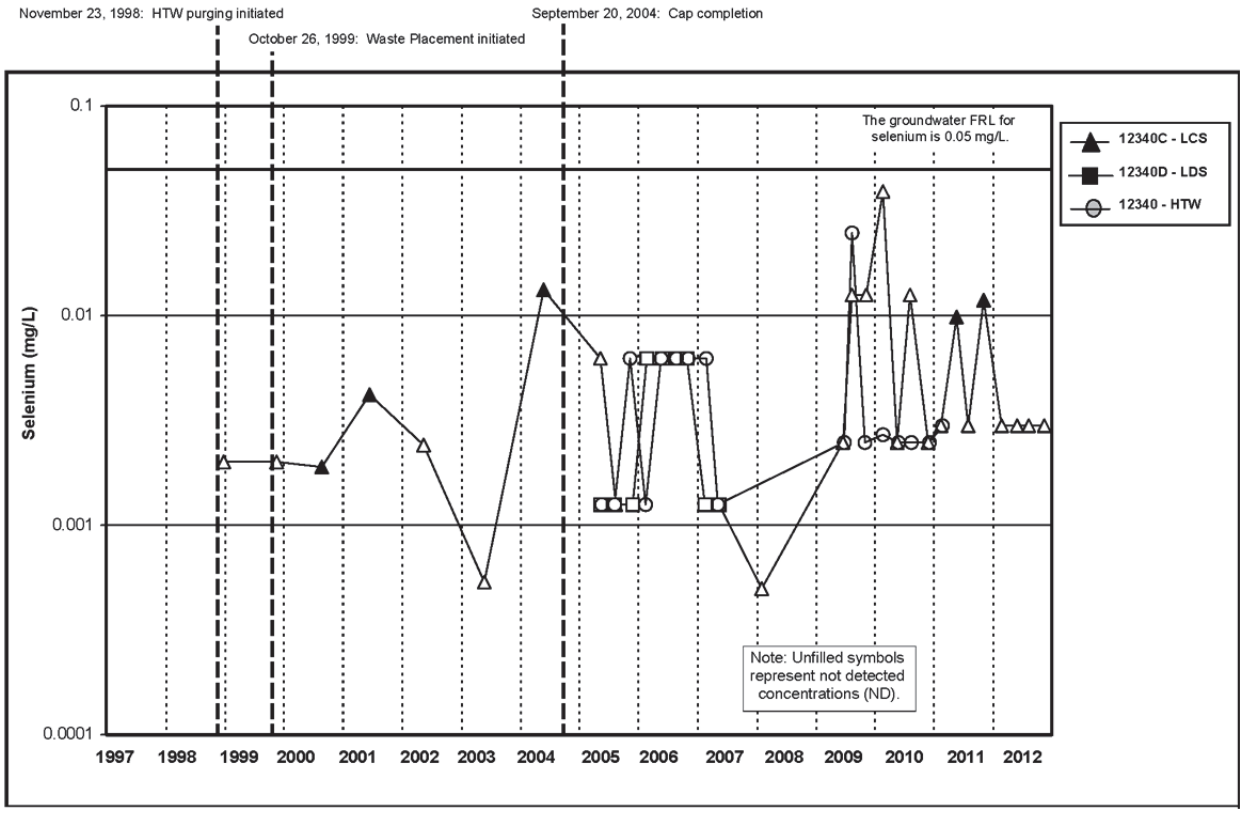


Figure A.5.3–26A. Cell 3 Selenium Concentration vs. Time Plot for LCS, LDS, and HTW

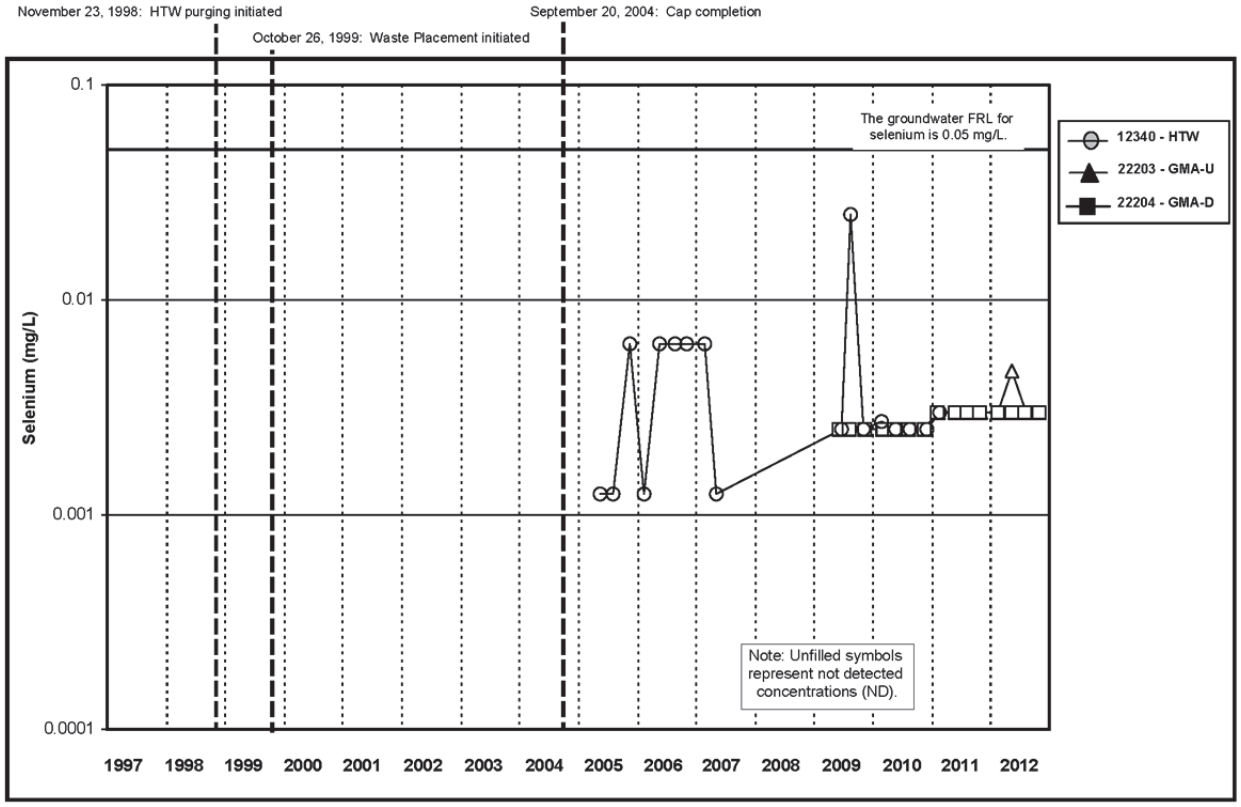


Figure A.5.3–26B. Cell 3 Selenium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

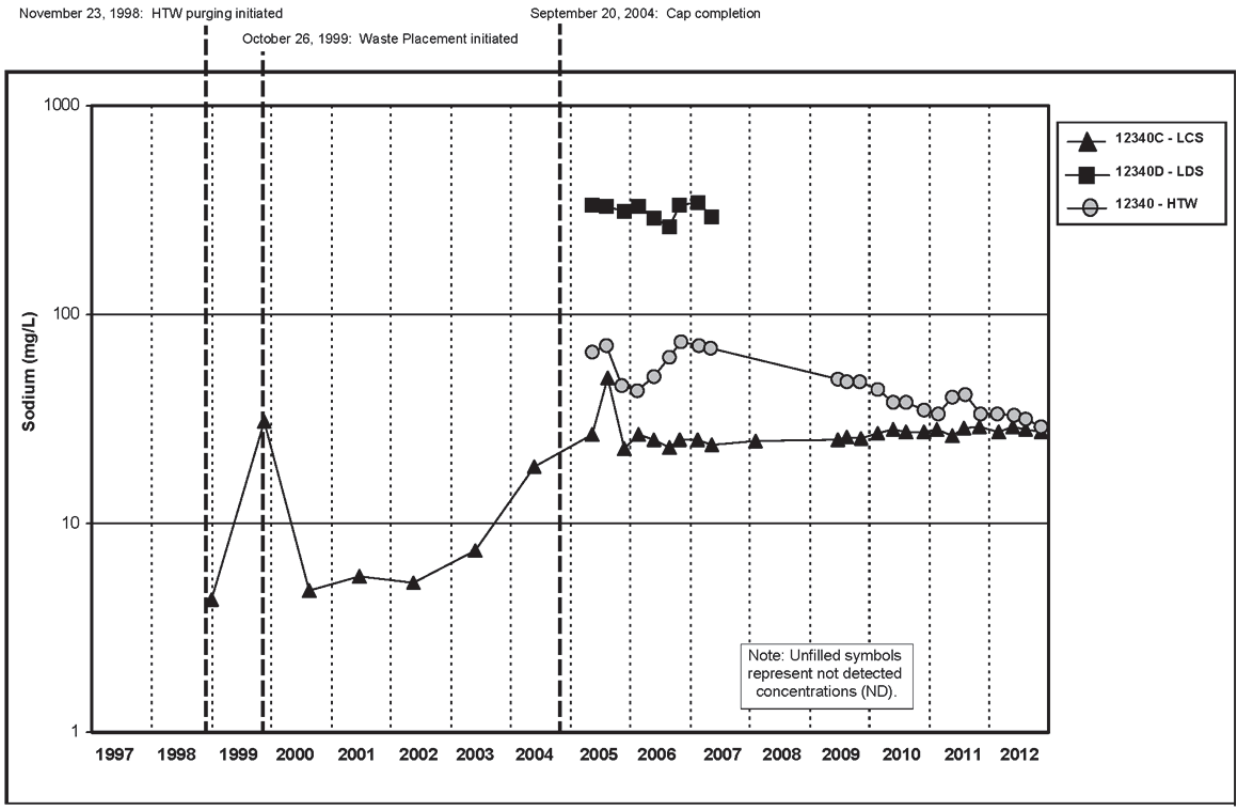
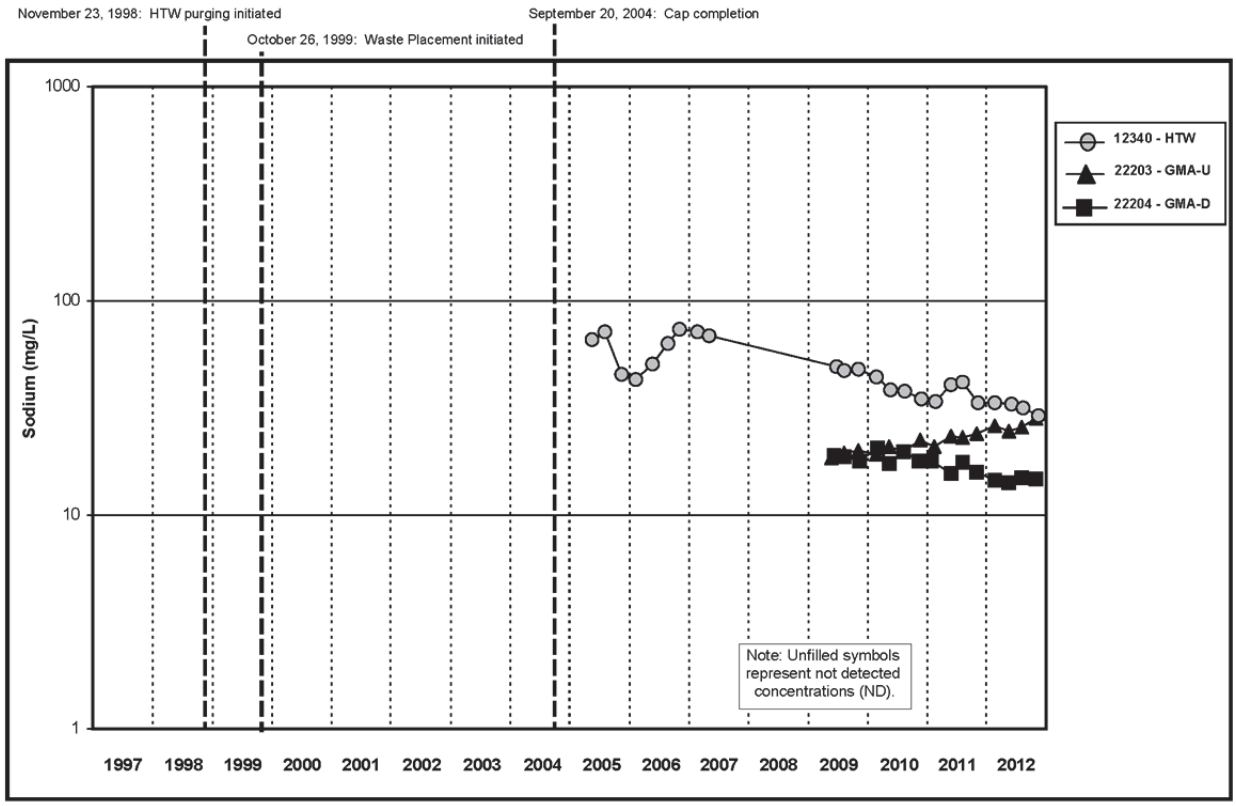


Figure A.5.3–27A. Cell 3 Sodium Concentration vs. Time Plot for LCS, LDS, and HTW



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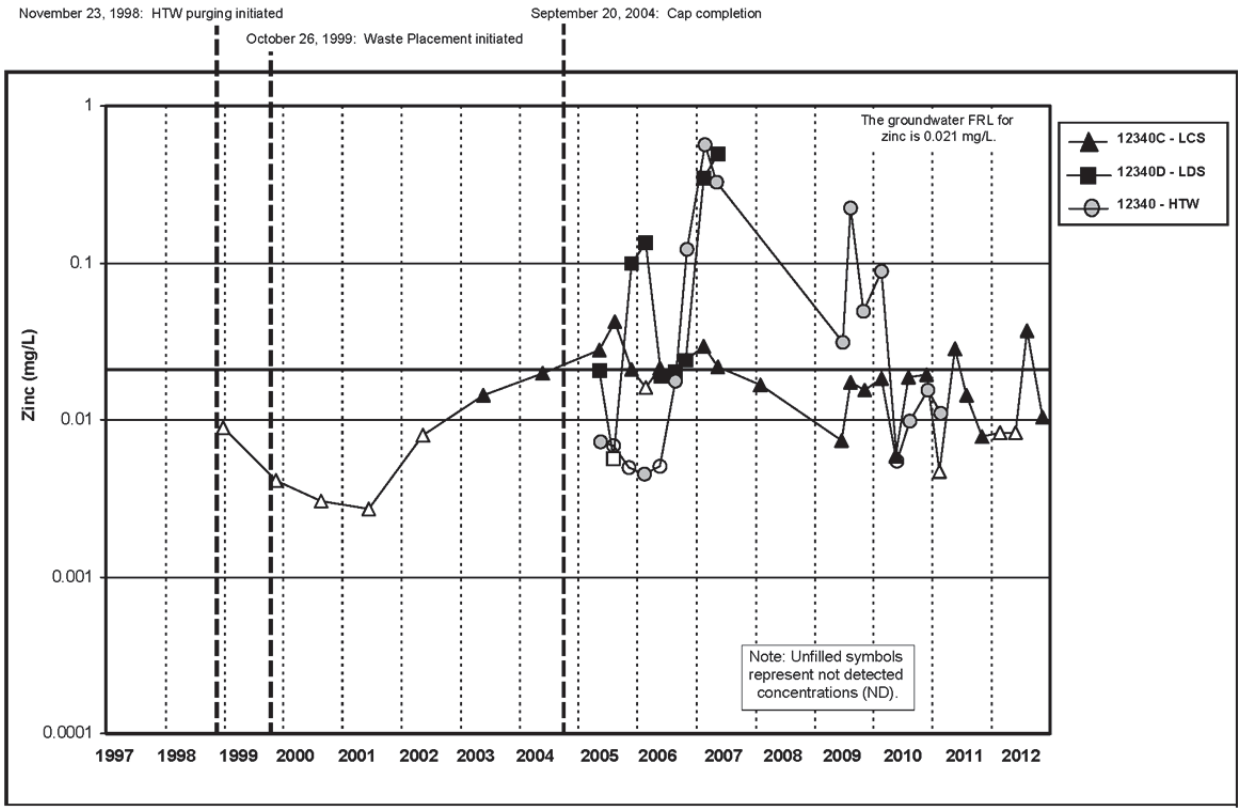

Figure A.5.3–28A. Cell 3 Zinc Concentration vs. Time Plot for LCS, LDS, and HTW

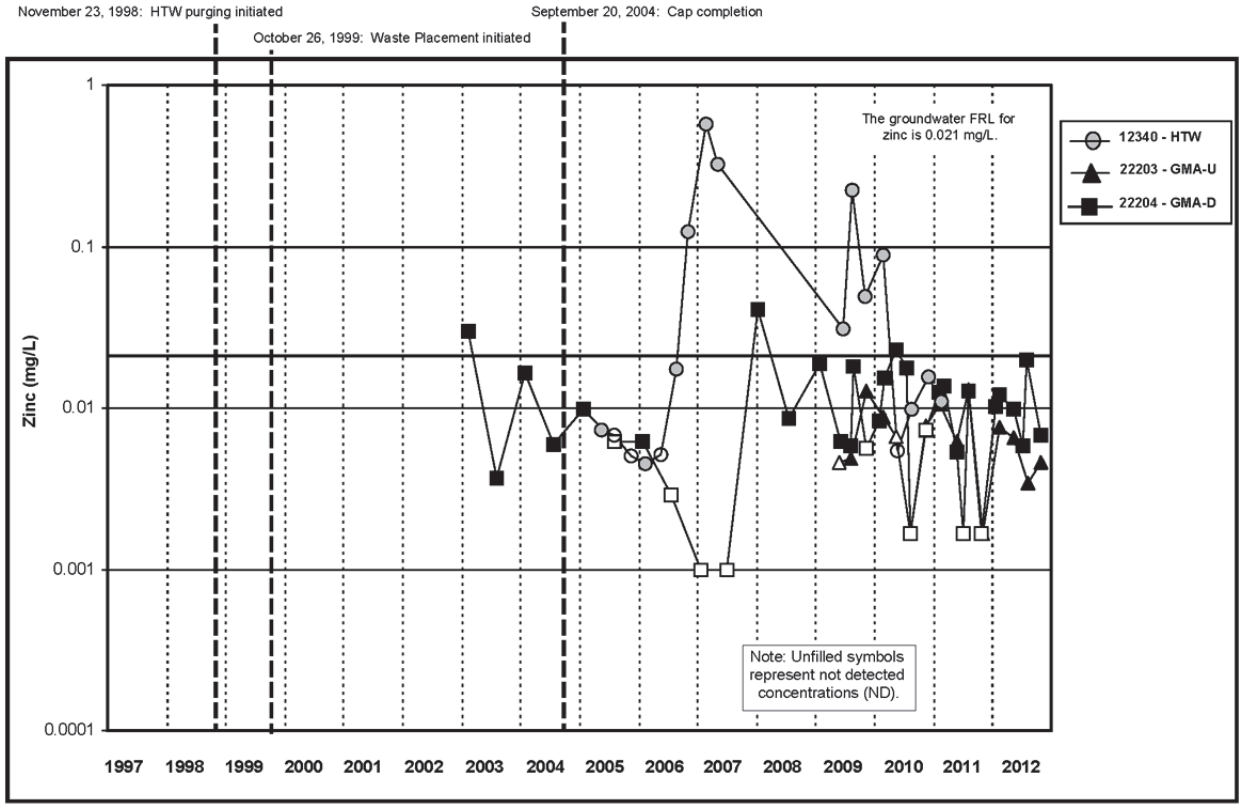

Figure A.5.3–28B. Cell 3 Zinc Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

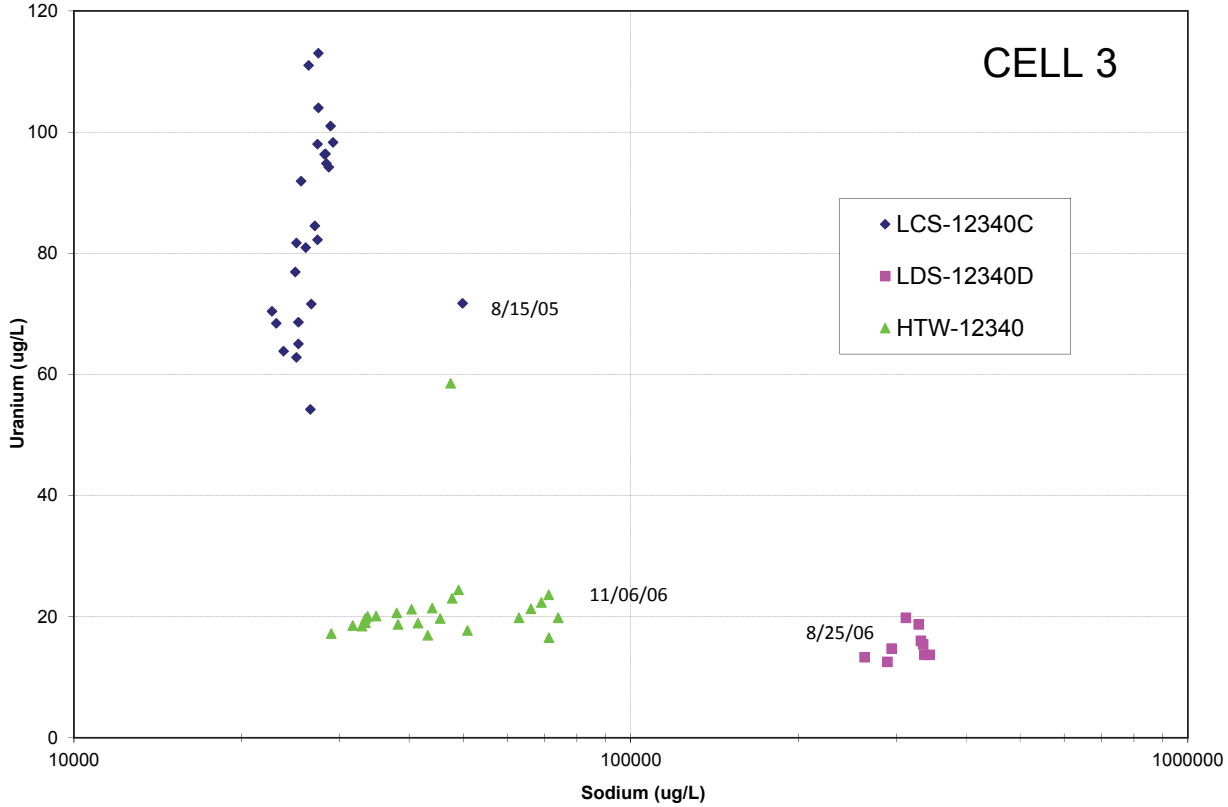

Figure A.5.3–29. Cell 3 Bivariate Plot for Uranium and Sodium

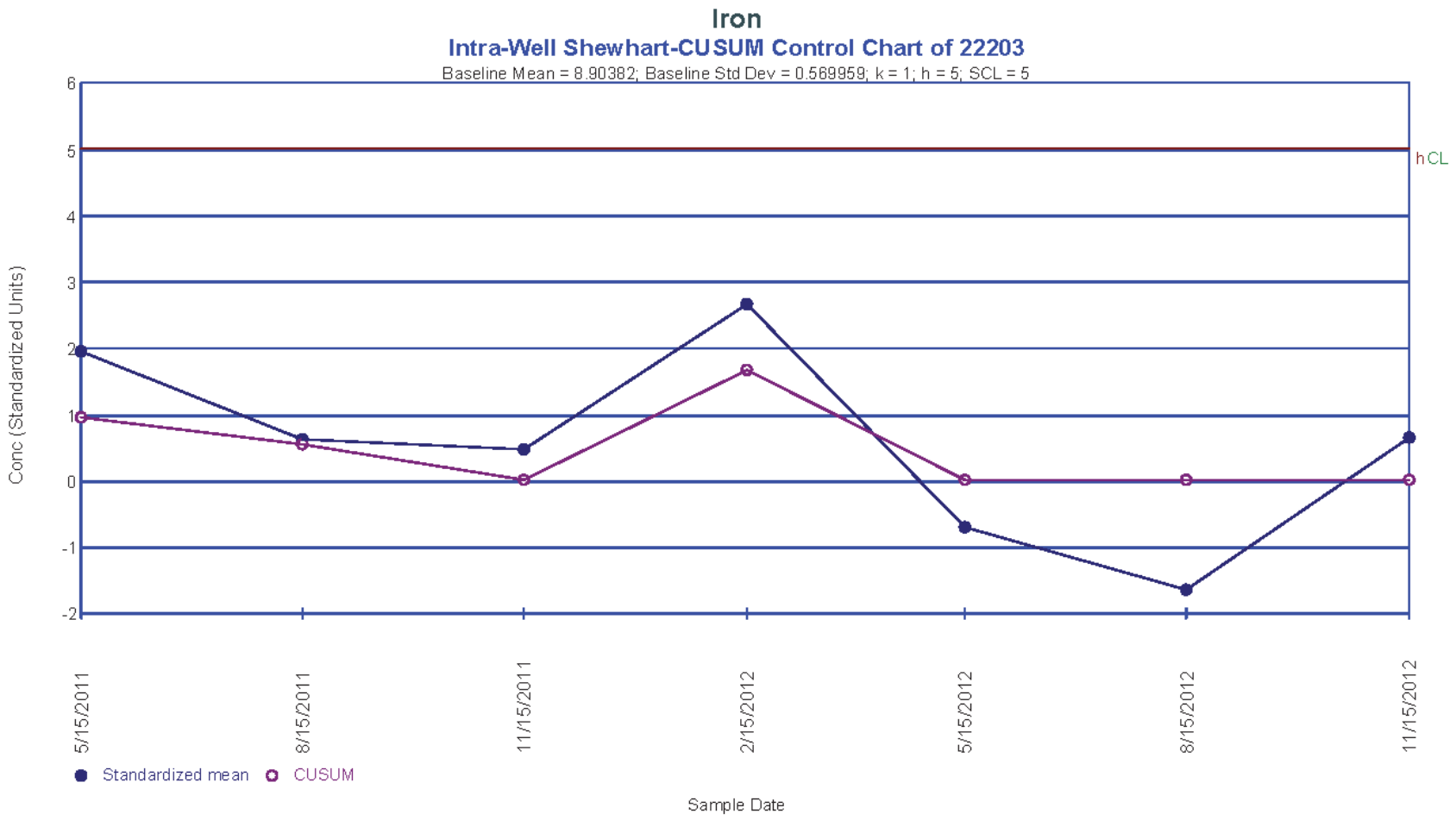

Figure A.5.3–30. Intra-Well Shewhart-CUSUM Control Chart (Iron 22203)

Figure A.5.3–31. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22203)

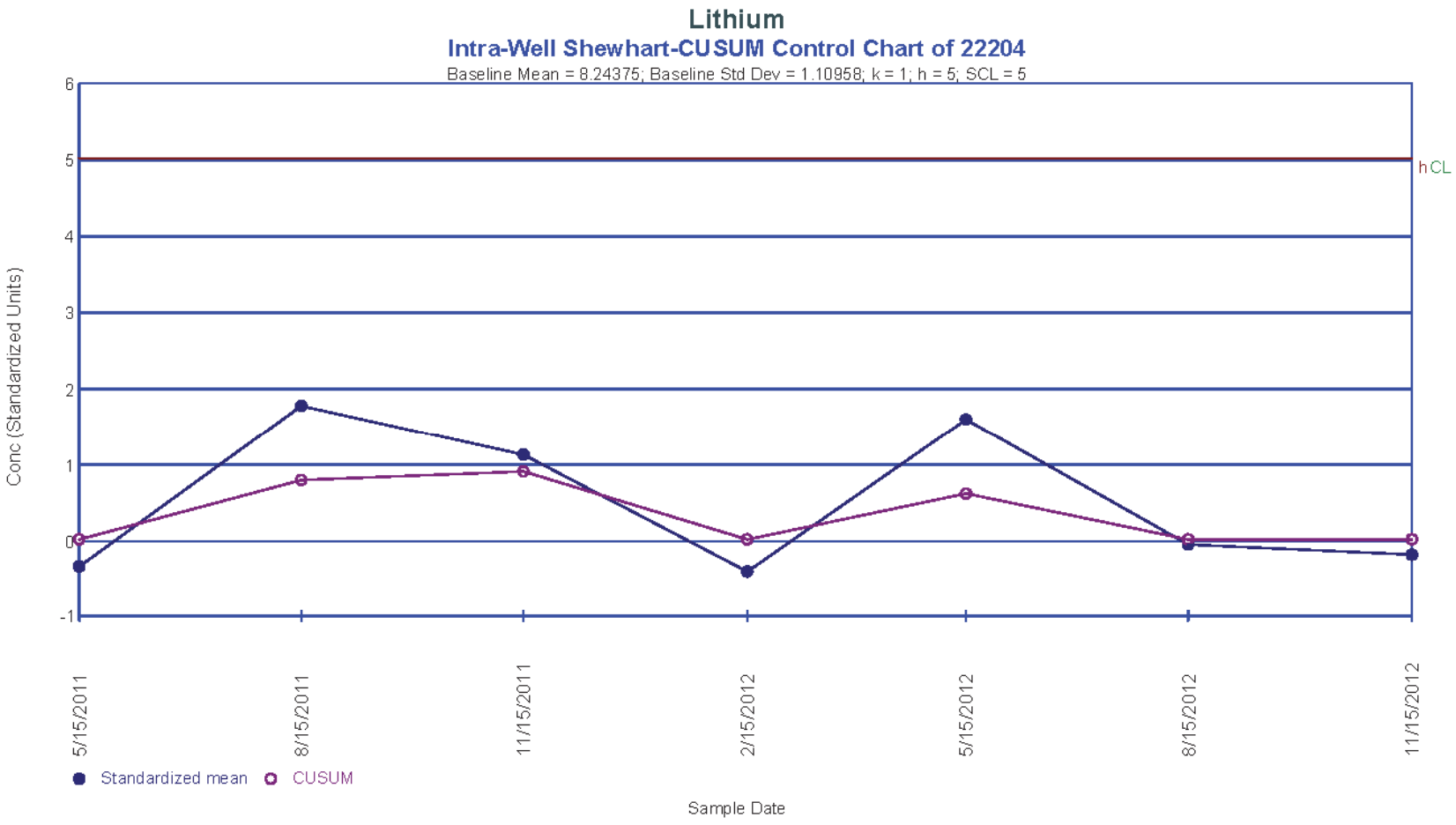

Figure A.5.3–32. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22204)

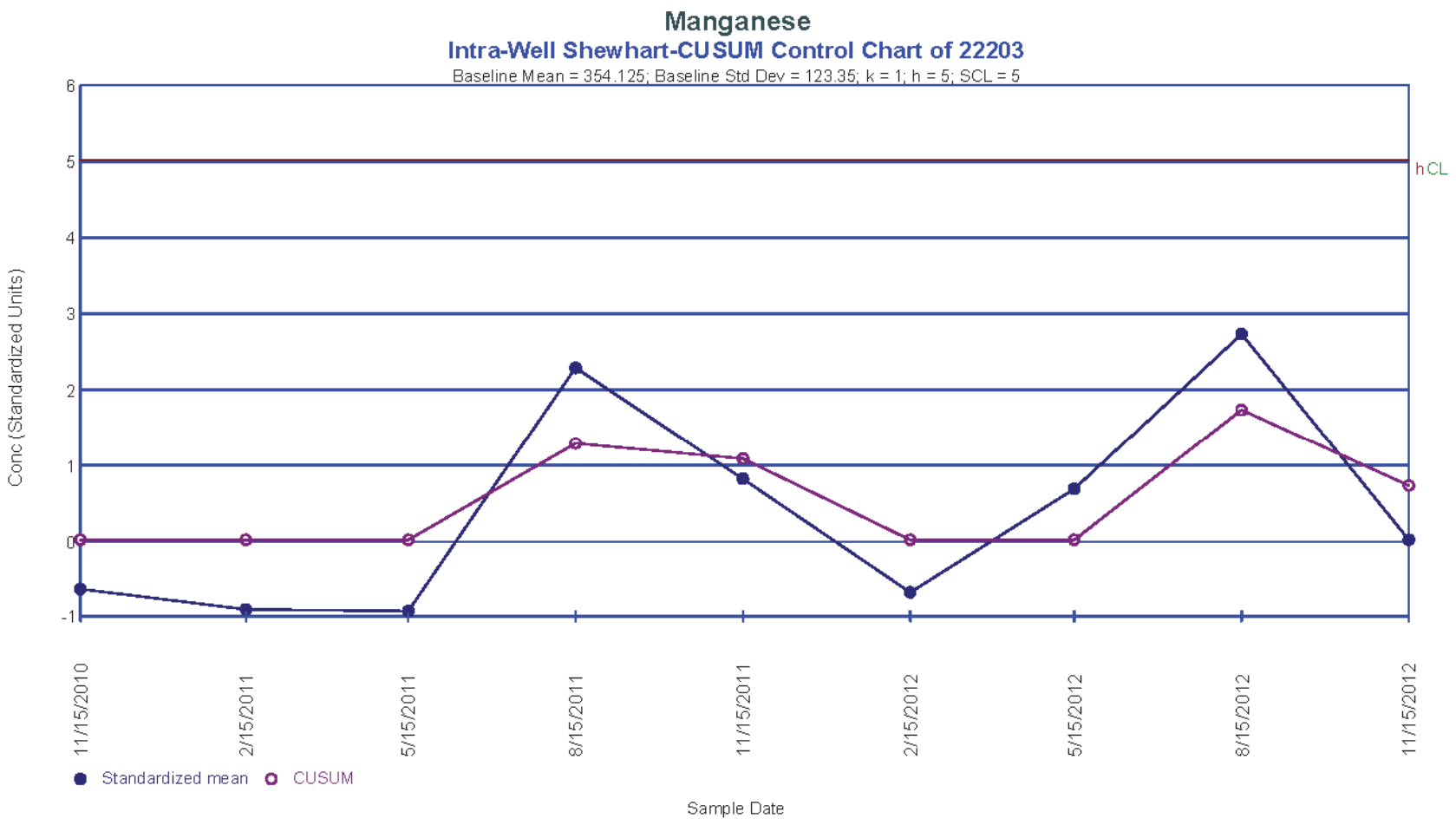

Figure A.5.3–33. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22203)

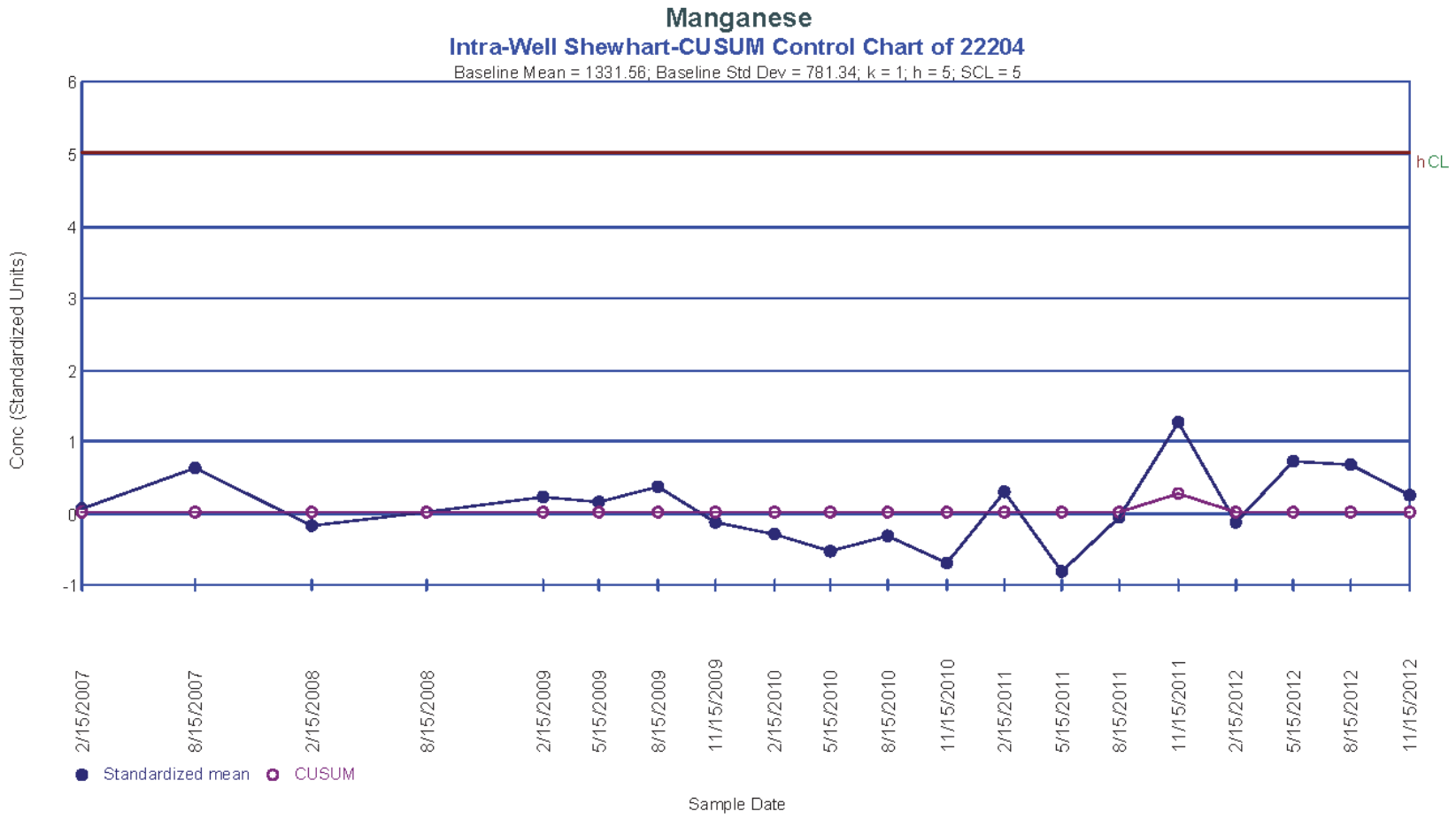

Figure A.5.3–34. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22204)

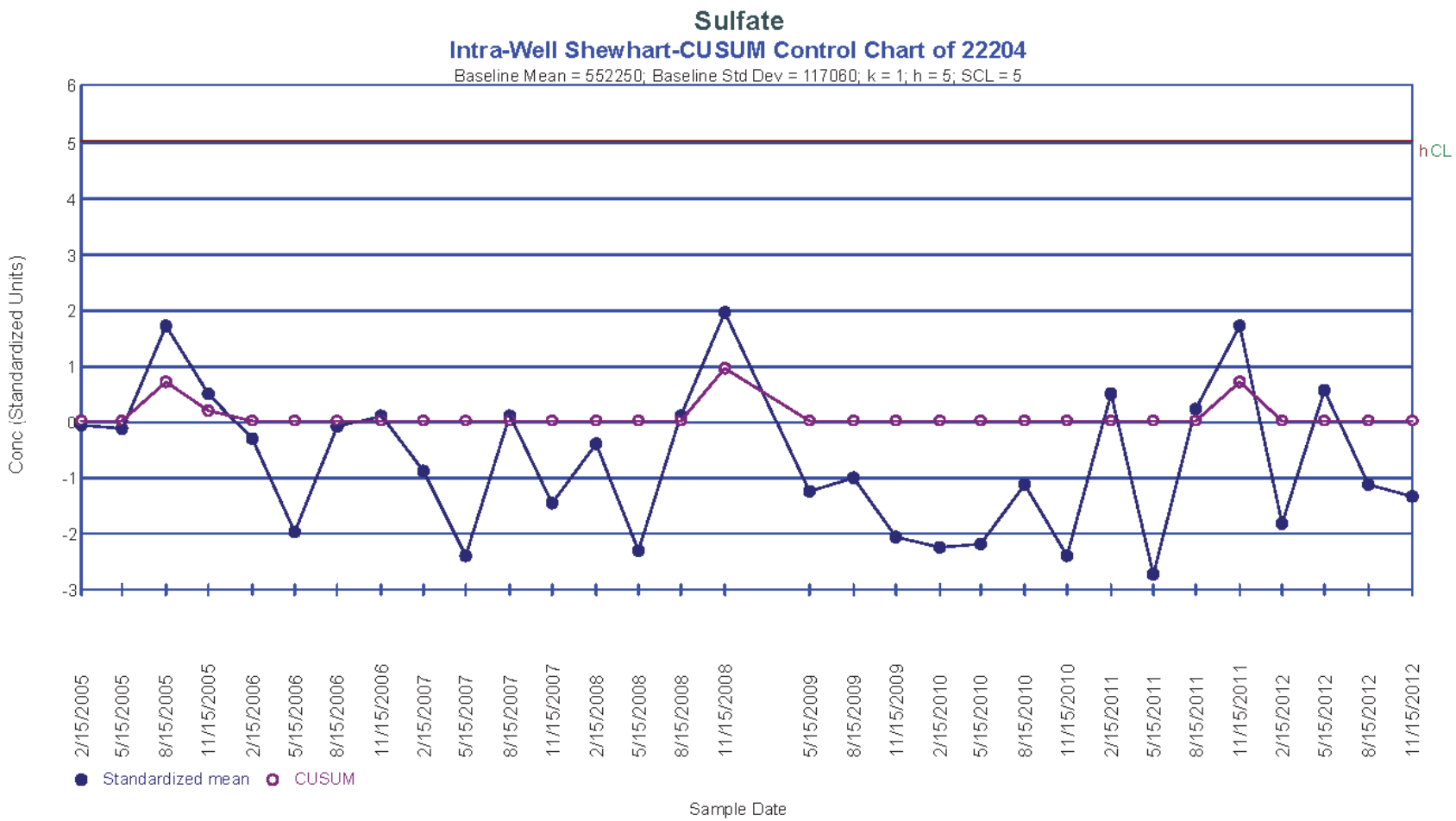

Figure A.5.3–35. Intra-Well Shewhart-CUSUM Control Chart (Sulfate 22204)

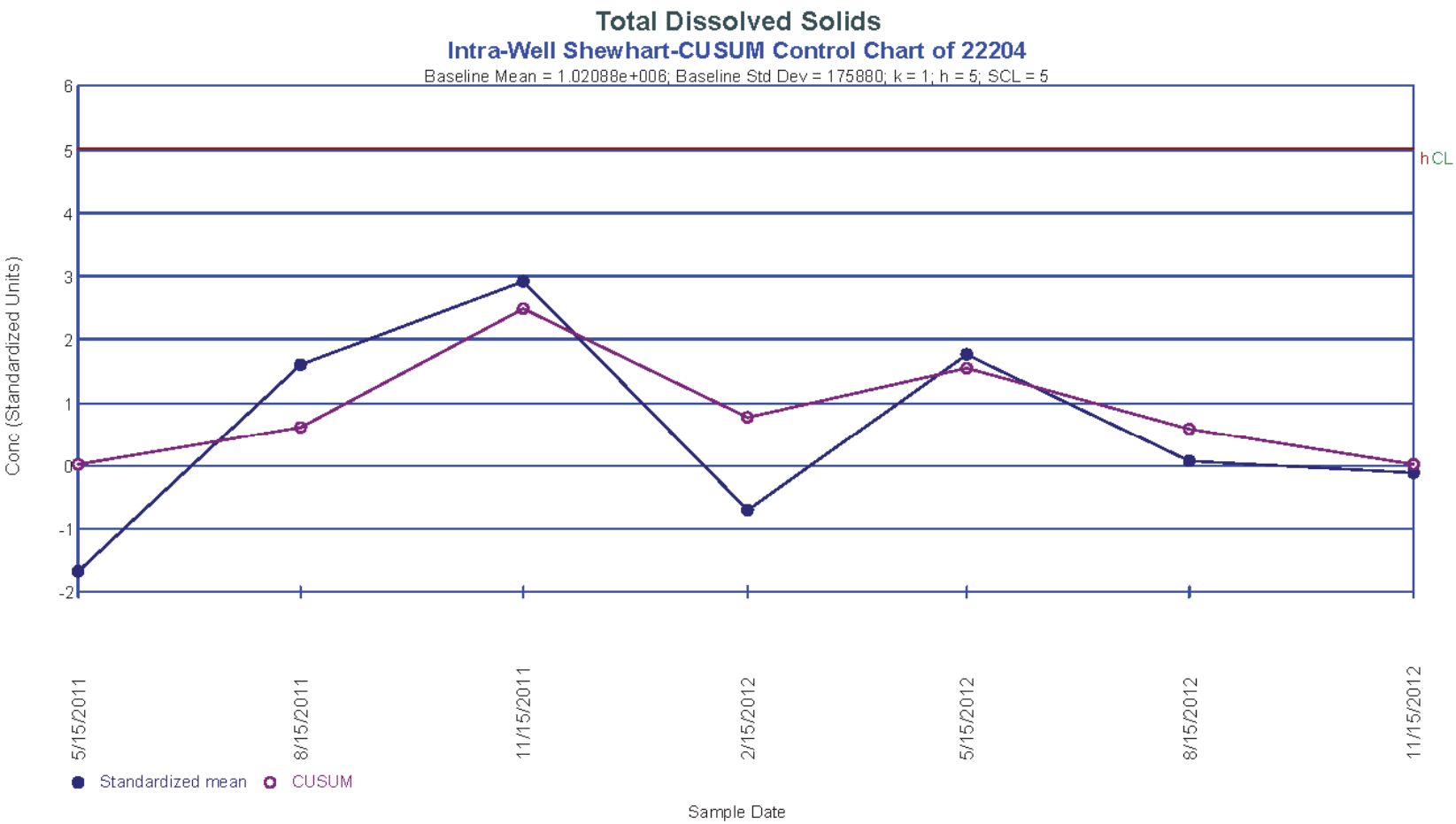

Figure A.5.3–36. Intra-Well Shewhart-CUSUM Control Chart (Total Dissolved Solids 22204)

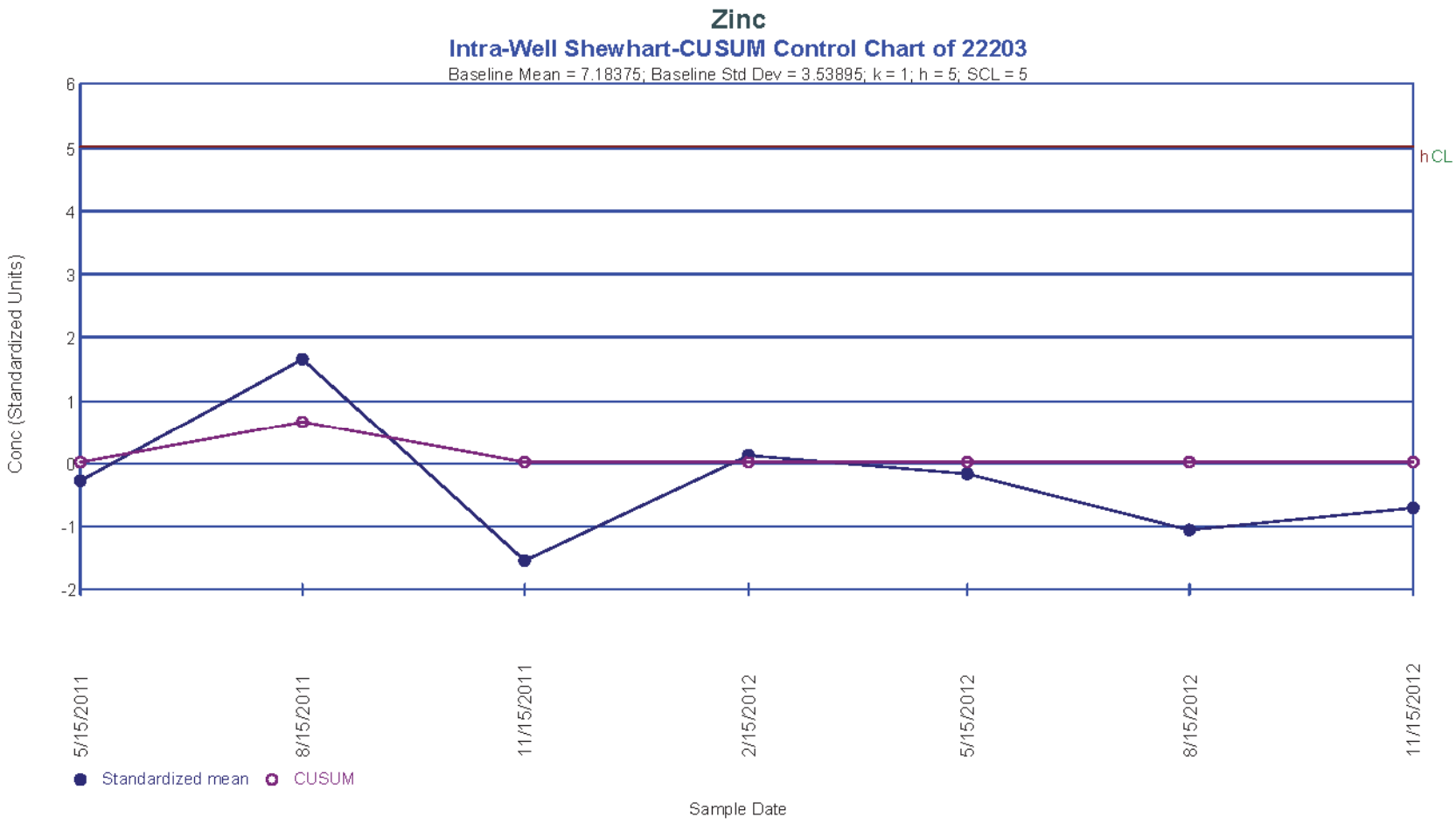

Figure A.5.3–37. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22203)

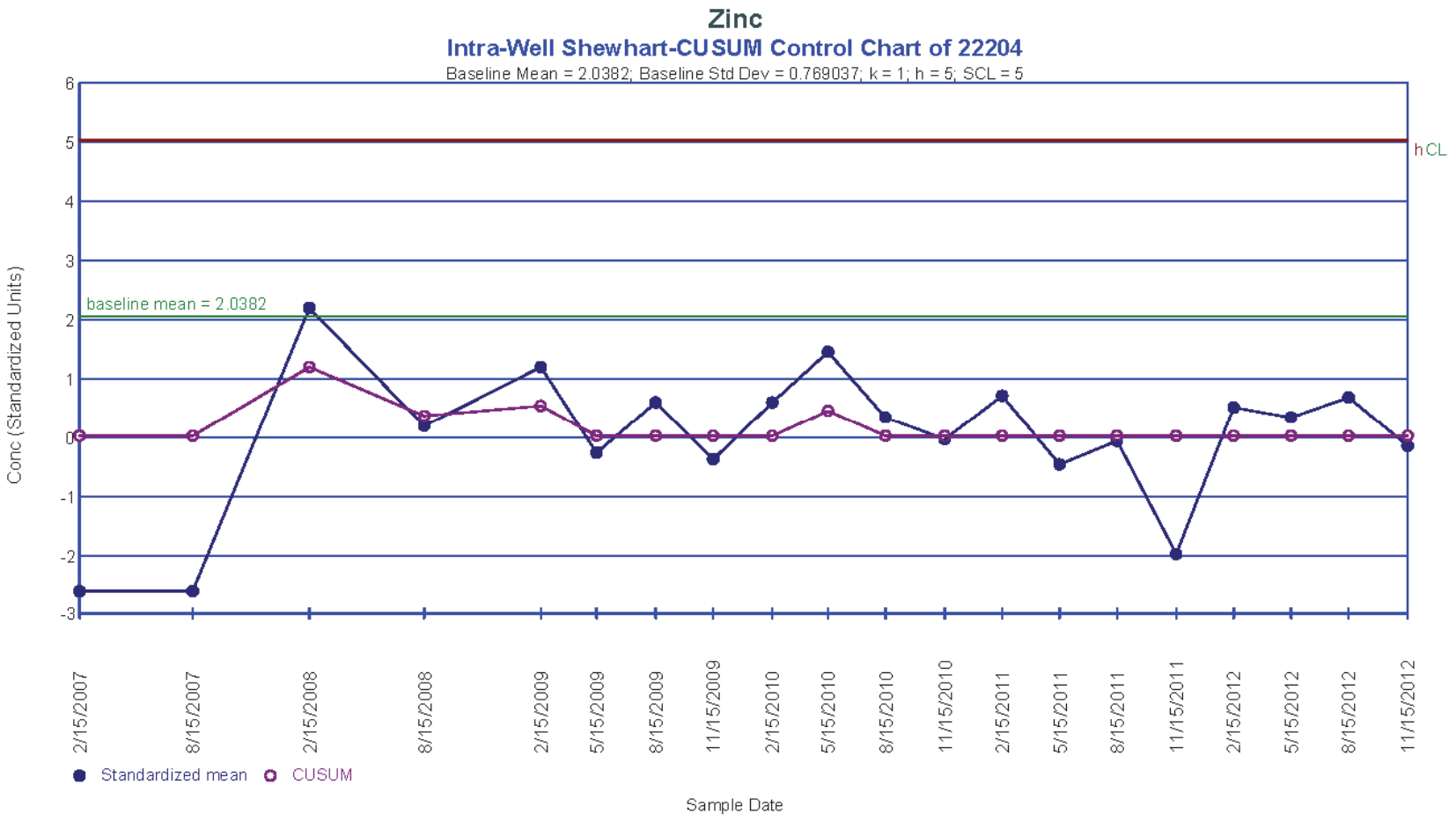

Figure A.5.3–38. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22204)

Sub-attachment A.5.4

Cell 4

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The following information is provided in this sub-attachment:

- Quarterly monitoring summary statistics (refer to Table A.5.4–1)
- Annual LCS sample summary information for detected parameters (refer to Table A.5.4–2)
- LCS monthly accumulation volumes (refer to Figure A.5.4–1)
- LDS monthly accumulation volumes (refer to Figure A.5.4–2)
- OSDF horizontal till well 12341 water yield (refer to Figure A.5.4–3)
- GMA water levels and uranium concentration versus time (refer to Figures A.5.4–4 and A.5.4–5)
- Plots of concentration versus time (refer to Figures A.5.4–6A to A.5.4–28B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.4–29)
- Control charts (refer to Figures A.5.4–30 to A.5.4–41)

A.5.4.1 Quarterly Monitoring Results

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within the cell is sampled in the LCS and LDS. Water quality beneath the cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present the results.

In 2012, 23 parameters were sampled in the LCS, LDS, and GMA wells of each cell. HTWs in all cells were sampled for arsenic, uranium, sodium, and sulfate. The LDS of Cell 4 was dry during 2012.

As shown in Table A.5.4–1, and summarized below, six parameters (sulfate, TOC, arsenic, boron, sodium, and zinc) have upward trends in the HTW and/or GMA wells based on the Mann-Kendall test for trend.

Parameters with upward concentration trends in the HTW and GMA Wells of Cell 4

Parameter	HTW[a] 12341	GMA-U[a] 22206	GMA-D[a] 22205
Sulfate	Up		
TOC		Up	Up
Arsenic	Up		Up
Boron			Up
Sodium		Up	
Zinc			Up

[a] HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer; TOC = total organic carbon. No entry indicates that the trend was not up.

The (uranium-sodium) bivariate plot for the Cell 4 LCS, LDS, and HTW is provided in Figure A.5.4–29. The plot shows that the chemical signature for uranium-sodium in the LCS, LDS, and HTW are separate and distinct; indicating that mixing between the horizons is not

occurring. Therefore, upward concentration trends measured beneath Cell 4 (i.e., in the HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

A.5.4.2 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 2009) defines the process of creating a Shewart-CUSUM control chart. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected, the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared "out of control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit.

A minimum of eight samples are recommended for use in ChemStat software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat software plots both a CUSUM control limit (h) and a SCL on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL.

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat software though, by default, plots both the SCL and CUSUM (h) control limits on the charts. As a "work-a-round", the SCL limit was defined as 5 to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

As shown in Table A.5.4–1 in gray shading, eight parameters in the HTW and/or GMA wells of Cell 4 (uranium, TDS, iron, lithium, manganese, sodium, sulfate, and zinc) meet the criteria for control charts (i.e., eight samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 12 control charts.

These 12 control charts are presented in Figures A.5.4–30 to A.5.4–41. All of the control charts for Cell 4 (with the exception of TDS in GMA Well 22206) exhibit "in control" conditions. As discussed above, separate and distinct signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 4 indicate that water is not mixing between horizons, so the out of control condition is attributed to fluctuating ambient conditions beneath the cell, and not to cell performance.

Parameter and Monitoring Point[a]	Assessment	Figure Number
Uranium in the GMA-U	In Control	A.5.4–30
Uranium in the GMA-D	In Control	A.5.4–31
TDS in the GMA-U	**Out of Control**	A.5.4–32
TDS in the GMA-D	In Control	A.5.4–33
Iron in the GMA-U	In Control	A.5.4–34
Iron in the GMA-D	In Control	A.5.4–35
Lithium in the GMA-U	In Control	A.5.4–36
Manganese in the GMA-U	In Control	A.5.4–37
Manganese in the GMA-D	In Control	A.5.4–38
Sodium in the HTW	In Control	A.5.4–39
Sulfate in the GMA-D	In Control	A.5.4–40
Zinc in the GMA-U	In Control	A.5.4–41

[a] GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer; TDS=total dissolved solids

A.5.4.3 Annual LCS Sample Results

Annual LCS sampling results for Cell 4 are provided in Table A.5.4–2 for those parameters that have been detected at least once and are not being sampled quarterly. No new Appendix I or PCB parameters were detected in the LCS of Cell 4 in 2012.

A.5.4.4 Summary and Conclusions

- The LDS of Cell 4 was dry in 2012.
- Six parameters monitored quarterly have an upward concentration in the HTW and/or GMA wells of Cell 4: sulfate, TOC, arsenic, boron, sodium, and zinc.
- Separate and distinct chemical signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 4 indicate that water is not mixing between the horizons. Therefore, upward concentration trends beneath Cell 4 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell, and not to cell performance.
- Twelve control charts were constructed for Cell 4 parameters. All but one (TDS in well 22206) exhibit “in control” conditions.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 4 in 2012.

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Table A.5.4–1. Summary Statistics for Cell 4

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Total Uranium (µg/L)	LCS	12341C	38	38	100	4.41	171	89.9	33.9	Undefined	None	Detected	
	LDS	12341D	34	34	100	5.74	21.3	14.2	2.9	Normal	None	Detected	
	HTW	12341	43	43	100	4.82	7.89	6.13	0.81	Undefined	Down	Not Detected	
	GMA-U	22206	40	44	90.9	ND	4.67	1.26	1.12	LogNormal	None	Not Detected	
	GMA-D	22205	45	45	100	0.525	12.1	2.75	2.67	LogNormal	None	Not Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12341C	23	23	100	48.0	583	357	130	Normal	None	Detected	
	LDS	12341D	13	13	100	142	450	305	106	Normal	None	Not Detected	
	GMA-U	22206	8	8	100	346	404	374	20	Normal	None	Not Detected	
	GMA-D	22205	8	8	100	382	426	406	15	Normal	None	Not Detected	
Chloride (mg/L)	LCS	12341C	22	23	95.6	ND	137	103	37	Undefined	Up	Detected	
	LDS	12341D	13	13	100	62.8	146	75.8	33.2	Undefined	Up	Not Detected	298(Q4-02)
	GMA-U	22206	8	8	100	21.6	39.2	31.7	5.3	Normal	None	Not Detected	
	GMA-D	22205	8	8	100	18.6	25.5	21.8	2.0	Normal	None	Not Detected	
Nitrate, Nitrite (mg/L)	LCS	12341C	18	27	66.7	ND	6.34	1.08	1.63	Undefined	None	Not Detected	
	LDS	12341D	5	13	38.5	ND	2.28	1.01	0.78	LogNormal	Up	Detected	
	GMA-U	22206	1	8	12.5	ND	0.025	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-D	22205	2	8	25.0	ND	0.0425	Insufficient	Insufficient	Normal	None	Not Detected	
Sulfate (mg/L)	LCS	12341C	38	38	100	140	3940	2460	840	Undefined	Up	Detected	
	LDS	12341D	34	34	100	1470	4490	2480	850	LogNormal	Up	Detected	7870(Q2-11)
	HTW	12341	34	34	100	153	375	231	55	LogNormal	Up	Detected	
	GMA-U	22206	39	39	100	90.4	559	250	112	LogNormal	Down	Detected	3720 (Q3-12)
	GMA-D	22205	39	39	100	199	535	332	85	Normal	None	Not Detected	
Total Dissolved Solids (mg/L)	LCS	12341C	26	26	100	351	5060	4660	1550	Undefined	Up	Detected	
	LDS	12341D	11	11	100	4810	7140	5920	890	Normal	Up	Detected	
	GMA-U	22206	15	15	100	559	877	668	102	LogNormal	None	Not Detected	
	GMA-D	22205	15	15	100	753	1180	939	127	Normal	None	Not Detected	
Total Organic Carbon (mg/L)	LCS	12341C	31	38	81.6	ND	5.39	2.56	1.02	Normal	None	Not Detected	
	LDS	12341D	31	34	91.2	ND	8.0	4.52	1.52	Normal	Down	Detected	
	GMA-U	22206	33	44	75.0	ND	2.39	1.50	0.48	Undefined	Up	Detected	9.84(Q2-03)
	GMA-D	22205	33	44	75.0	ND	2.74	1.57	0.50	Normal	Up	Detected	
Total Organic Halogens (mg/L)	LCS	12341C	25	38	65.8	ND	0.060	0.0171	0.0123	Normal	None	Not Detected	
	LDS	12341D	26	34	76.5	ND	0.0445	0.0206	0.0113	Normal	None	Not Detected	0.070(Q2-10)
	GMA-U	22206	18	44	40.9	ND	0.064	0.0073	0.0103	Log Normal	Down	Not Detected	
	GMA-D	22205	8	44	18.2	ND	0.0142	0.00253	0.00439	Undefined	Down	Detected	
Arsenic (mg/L)	LCS	12341C	5	28	17.9	ND	0.126	0.00275	0.0276	Undefined	None	Detected	
	LDS	12341D	6	20	30.0	ND	0.0274	0.0068	0.0076	LogNormal	None	Not Detected	
	HTW	12341	11	24	45.8	ND	0.0307	0.0057	0.0189	Normal	Up	Detected	0.0938(Q3-09)
	GMA-U	22206	5	15	33.3	ND	0.0365	0.0025	0.0104	Undefined	None	Not Detected	
	GMA-D	22205	4	28	14.3	ND	0.0344	0.0025	0.0096	Undefined	Up	Detected	
Barium (mg/L)	LCS	12341C	23	23	100	0.0155	0.0580	0.0271	0.0104	Undefined	Down	Not Detected	
	LDS	12341D	13	13	100	0.0167	0.0775	0.0388	0.0201	Normal	Down	Detected	
	GMA-U	22206	8	8	100	0.058	0.0782	0.0665	0.0066	Normal	None	Not Detected	
	GMA-D	22205	8	8	100	0.0478	0.0703	0.0615	0.0076	Normal	None	Not Detected	
Boron (mg/L)	LCS	12341C	38	38	100	0.0626	1.27	0.886	0.270	Undefined	None	Detected	1.930(Q3-05)
	LDS	12341D	34	34	100	0.415	1.81	0.634	0.310	Undefined	None	Detected	
	GMA-U	22206	39	44	88.6	ND	6.17	0.0416	0.00922	Undefined	None	Detected	
	GMA-D	22205	37	44	84.1	ND	0.0807	0.0417	0.0143	Normal	Up	Detected	

Table A.5.4−1 (continued). Summary Statistics for Cell 4

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Calcium (mg/L)	LCS	12341C	23	23	100	52.9	1110	521	186	Undefined	None	Not Detected	
	LDS	12341D	13	13	100	284	578	424	88	Normal	None	Not Detected	
	GMA-U	22206	8	8	100	141	217	178	32	Normal	None	Not Detected	
	GMA-D	22205	8	8	100	193	268	230	26	Normal	Down	Detected	
Cobalt (mg/L)	LCS	12341C	13	28	46.4	ND	0.0057	0.0005	0.0014	Undefined	None	Detected	
	LDS	12341D	11	20	55.0	ND	0.0064	0.0015	0.0018	Undefined	Down	Detected	
	GMA-U	22206	0	15	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22205	4	15	26.7	ND	0.00211	0.0005	0.0006	Undefined	None	Not Detected	
Copper (mg/L)	LCS	12341C	14	24	58.3	ND	0.0309	0.0086	0.0081	Undefined	None	Detected	
	LDS	12341D	10	15	66.7	ND	0.0259	0.0115	0.0080	Normal	None	Not Detected	
	GMA-U	22206	7	8	87.5	ND	0.0106	0.00513	0.00428	Undefined	None	Not Detected	
	GMA-D	22205	7	8	87.5	ND	0.0183	0.0067	0.0060	Normal	None	Not Detected	
Iron (mg/L)	LCS	12341C	21	28	75.0	ND	4.18	0.0813	1.30	Undefined	Down	Detected	
	LDS	12341D	16	20	80.0	ND	27.8	9.02	6.39	LogNormal	Down	Detected	
	GMA-U	22206	15	15	100	0.986	15.0	8.26	3.68	Normal	None	Not Detected	
	GMA-D	22205	15	15	100	2.3	9.37	6.09	1.61	Normal	None	Not Detected	
Lithium (mg/L)	LCS	12341C	24	24	100	0.0818	0.187	0.129	0.031	Normal	Up	Detected	
	LDS	12341D	19	19	100	0.0951	0.331	0.174	0.066	Normal	Up	Detected	
	GMA-U	22206	15	15	100	0.0111	0.0175	0.0143	0.0016	Normal	None	Not Detected	
	GMA-D	22205	15	15	100	0.00685	0.00946	0.00810	0.00082	Normal	None	Detected	0.0167(Q3-11)
Magnesium (mg/L)	LCS	12341C	23	23	100	15	732	452	187	Undefined	Up	Detected	
	LDS	12341D	13	13	100	159	548	189	158	Undefined	Up	Detected	
	GMA-U	22206	8	8	100	30.2	43.8	36.0	4.8	Normal	None	Not Detected	
	GMA-D	22205	8	8	100	45.2	63.2	50.6	5.8	Normal	None	Not Detected	
Manganese (mg/L)	LCS	12341C	15	28	53.6	ND	2.14	0.010	0.450	Undefined	Down	Detected	
	LDS	12341D	12	20	60.0	ND	1.85	0.955	0.496	LogNormal	Down	Detected	
	GMA-U	22206	17	17	100	0.311	0.708	0.456	0.116	Normal	None	Not Detected	
	GMA-D	22205	27	28	96.4	ND	1.10	0.645	0.191	Normal	None	Not Detected	
Nickel (mg/L)	LCS	12341C	24	28	85.7	ND	0.0474	0.0110	0.0123	LogNormal	Up	Detected	
	LDS	12341D	18	20	90.0	ND	0.0474	0.0178	0.0118	Normal	None	Detected	
	GMA-U	22206	1	15	6.7	ND	0.00147	Insufficient	Insufficient	Undefined	None	Detected	
	GMA-D	22205	11	28	39.3	ND	0.0135	0.00075	0.00278	Undefined	None	Detected	
Potassium (mg/L)	LCS	12341C	23	23	100	3.81	78.4	21.9	13.2	Undefined	None	Not Detected	
	LDS	12341D	13	13	100	31	137	36.5	30.3	Undefined	None	Detected	
	GMA-U	22206	8	8	100	3.84	4.39	4.05	0.21	Normal	None	Not Detected	
	GMA-D	22205	8	8	100	2.49	3.22	2.74	0.24	Normal	Down	Detected	

Table A.5.4−1 (continued). Summary Statistics for Cell 4

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Selenium (mg/L)	LCS	12341C	7	28	25.0	ND	0.231	0.0030	0.0449	Undefined	None	Not Detected	
	LDS	12341D	2	20	10.0	ND	0.067	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-U	22206	0	15	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22205	0	15	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Sodium (mg/L)	LCS	12341C	28	28	100	22	117	52.8	16.8	Undefined	Up	Not Detected	
	LDS	12341D	20	20	100	307	623	458	87	Normal	Up	Detected	
	HTW	12341	24	24	100	14.1	18.1	15.4	0.9	Normal	None	Not Detected	
	GMA-U	22206	15	15	100	12.3	18.0	14.6	1.8	Normal	Up	Not Detected	
	GMA-D	22205	15	15	100	14.9	22.2	18.8	2.2	Normal	None	Detected	
Zinc (mg/L)	LCS	12341C	13	28	46.4	ND	0.0446	0.0140	0.0101	LogNormal	Up	Not Detected	
	LDS	12341D	17	20	85.0	ND	0.775	0.311	0.251	LogNormal	None	Detected	
	GMA-U	22206	9	15	60.0	ND	0.0201	0.0081	0.0050	Normal	None	Not Detected	
	GMA-D	22205	16	28	57.1	ND	0.00859	0.0041	0.0020	Normal	Up	Not Detected	

Note 1: Shading identifies a horizontal till well or Great Miami Aquifer well, with more than 8 samples, normal or lognormal distribution, no trend, and no serial correlation. These wells meet control chart criteria.

Note 2: Data used in this table has been standardized to quarterly.

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]ND = not detected; NA = not applicable

[c]Averages were determined based on the distribution assumption.

[d]Insufficient is used for Distribution Type, Trend, or Serial Correlation whenever there is not enough data to run the test for average whenever there are less than 3 detections, and for standard deviation whenever there are less than 4 detections.

[e]Data distribution based on the Shapiro-Wilk statistic.

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[f]Trend based on nonparametric Mann-Kendall procedure.

[g]Serial correlation based on Rank Von Neumann test.

[h]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 25).

[i]Q = quarterly

Table A.5.4–2. Cell 4 Annual LCS Sample Summary Information for Detected Parameters

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	DETECTED IN 2012	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)
General Chemistry											
Ammonia (mg/L)	11	5	45.5	Yes	0.0268	0.133	0.0683	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganic											
Chromium (mg/L)	11	4	36.4	No	0.003	0.0137	0.0065	0.022 mg/L[g](0)	0.021 mg/L(0)	0.0046 mg/L(2)	0.818 mg/L(0)
Lead (mg/L)	11	1	9.1	No	0.0185	-	-	0.015 mg/L(1)	0.022 mg/L(0)	0.0016 mg/L(1)	0.0114 mg/L(1)
Radionuclides											
Technetium-99 (pCi/L)	17	5	29.4	No	1.21	37.8	14.5	94 pCi/L(0)	22 pCi/L(1)	30 pCi/L(1)	6130 pCi/L(0)
Organics											
1,1-Dichloroethane (ug/L)	9	1	11.1	No	0.332	-	-	280 ug/L(0)	-	-	-
Acetone (ug/L)	9	1	11.1	No	2.35	-	-	-	-	-	-

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on hexavalent chromium from Operable Unit 5 Record of Decision, Table 9-4.

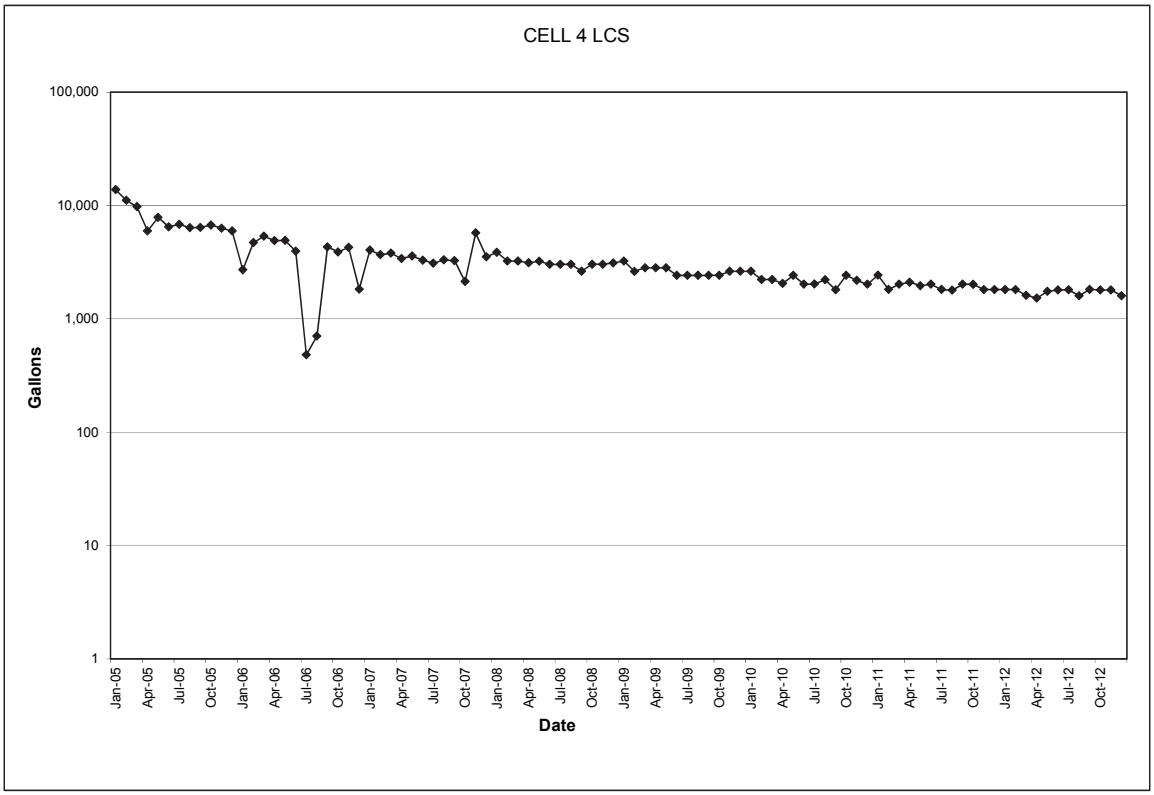


Figure A.5.4–1. Monthly Accumulation Volumes For Cell 4 LCS

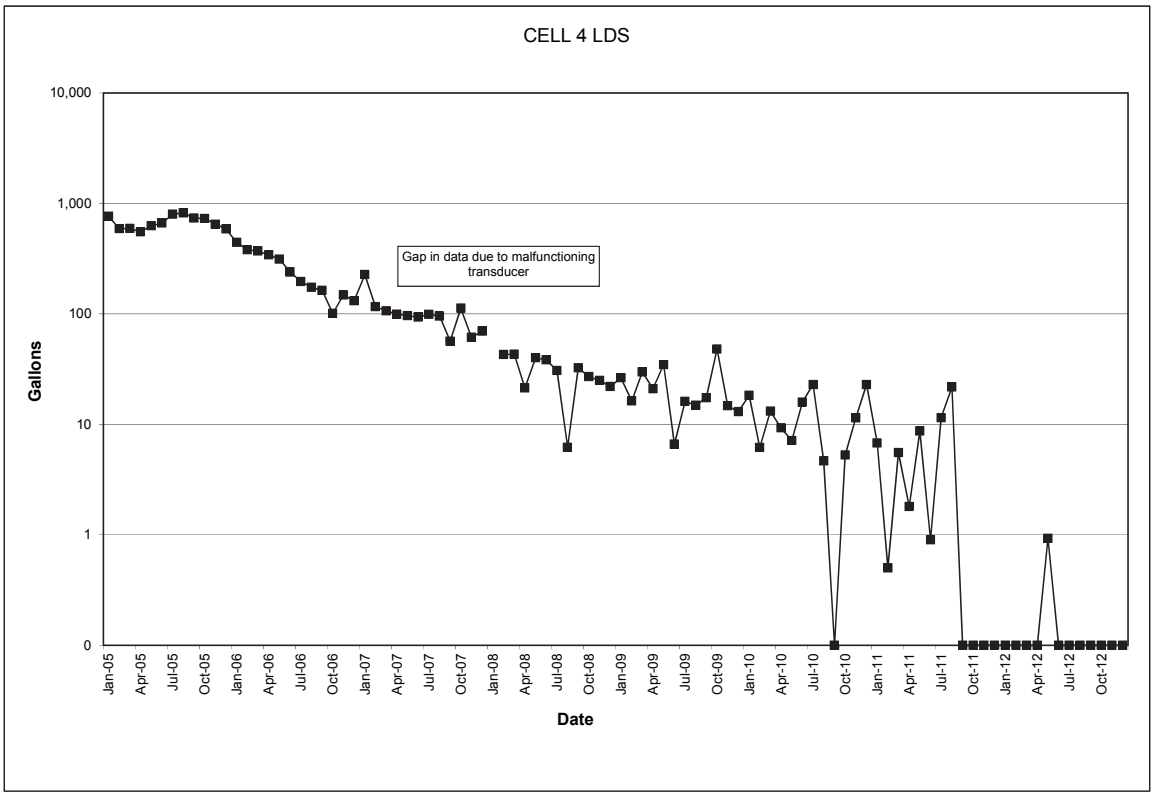
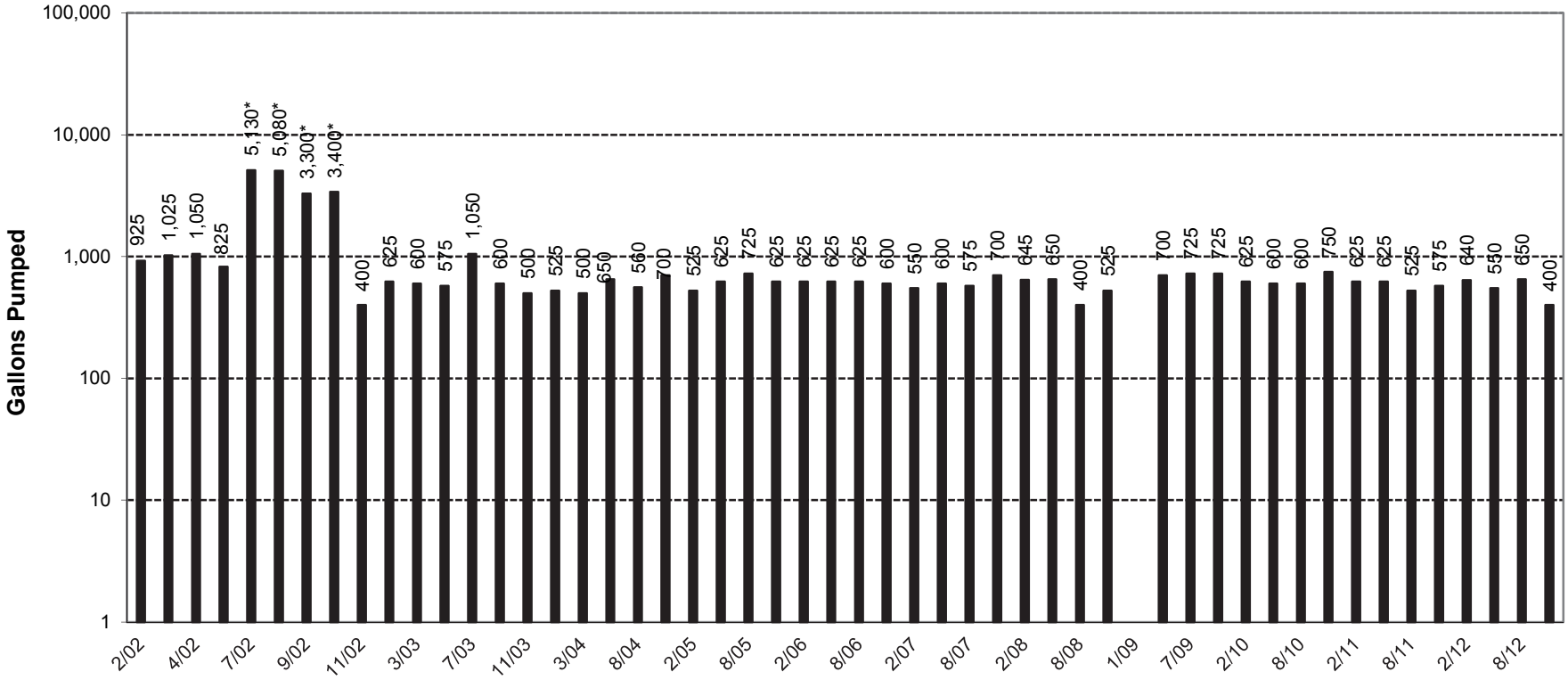


Figure A.5.4–2. Monthly Accumulation Volumes For Cell 4 LDS



12341 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
2002:	21115	n=9	2346
2003:	3950	n=6	658
2004:	2935	n=5	587
2005:	2500	n=4	625
2006:	2475	n=4	619
2007:	2425	n=4	606
2008:	2220	n=4	555
2009:	2150	n=3	717
2010:	2575	n=4	644
2011:	2350	n=4	588
2012:	2240	n=4	560
Overall:			920

*More than one purge of the well was completed during these months to drain perched water and infiltrating surface water so the compacted clay liner could be constructed.

Figure A.5.4–3. OSDF Horizontal Till Well 12341 (Cell 4) Water Yield

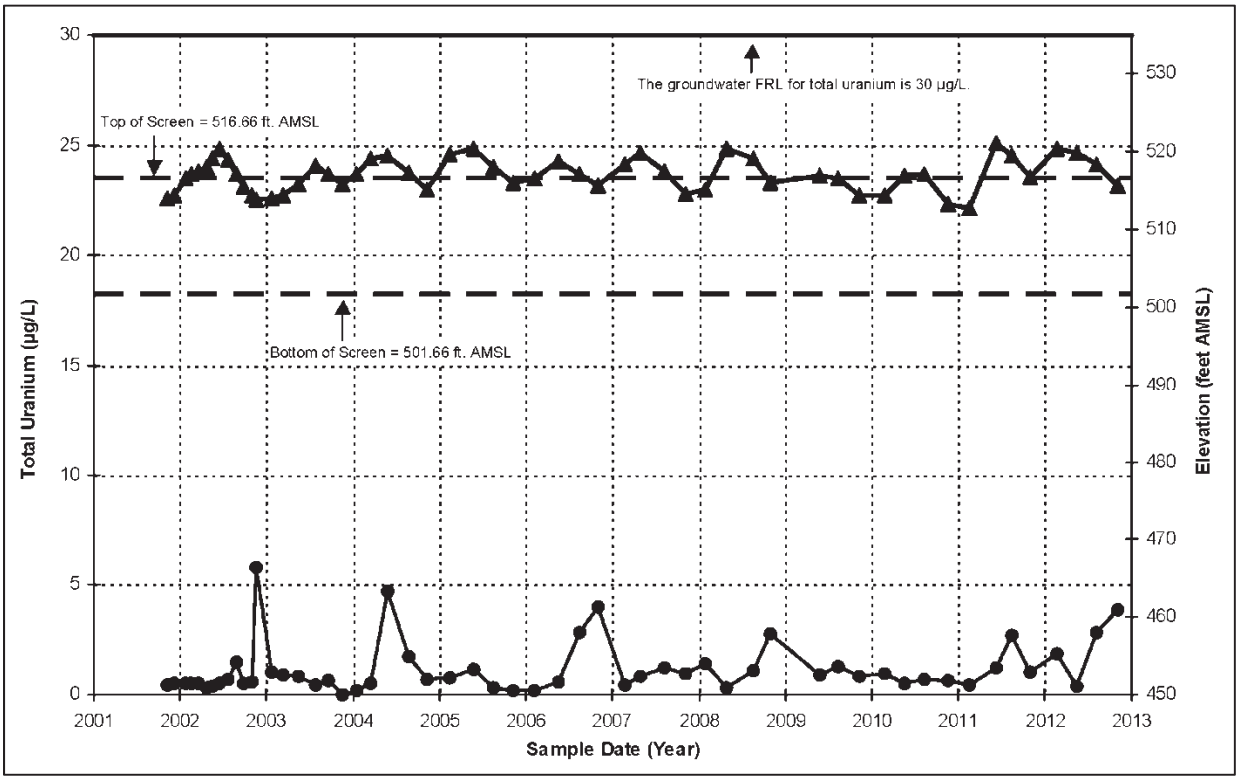


Figure A.5.4–4. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 4 Upgradient Monitoring Well 22206

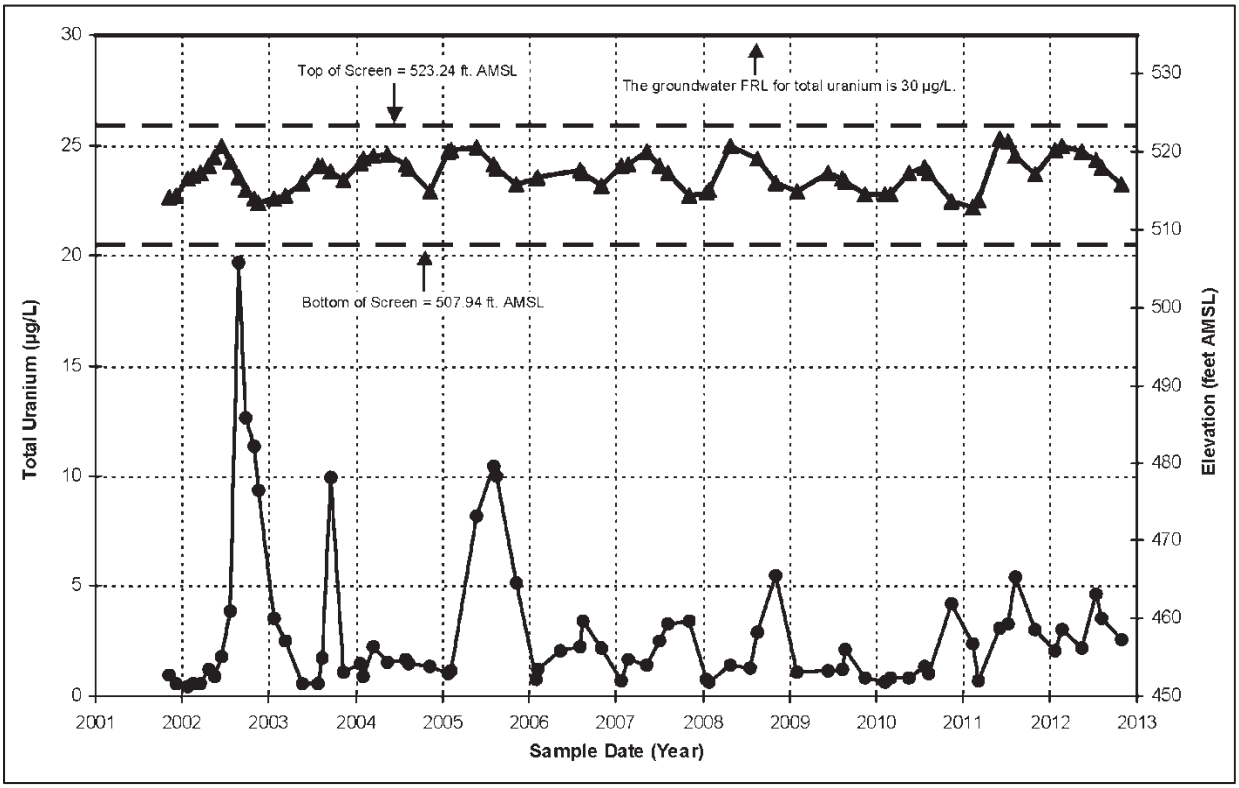


Figure A.5.4–5. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 4 Downgradient Monitoring Well 22505

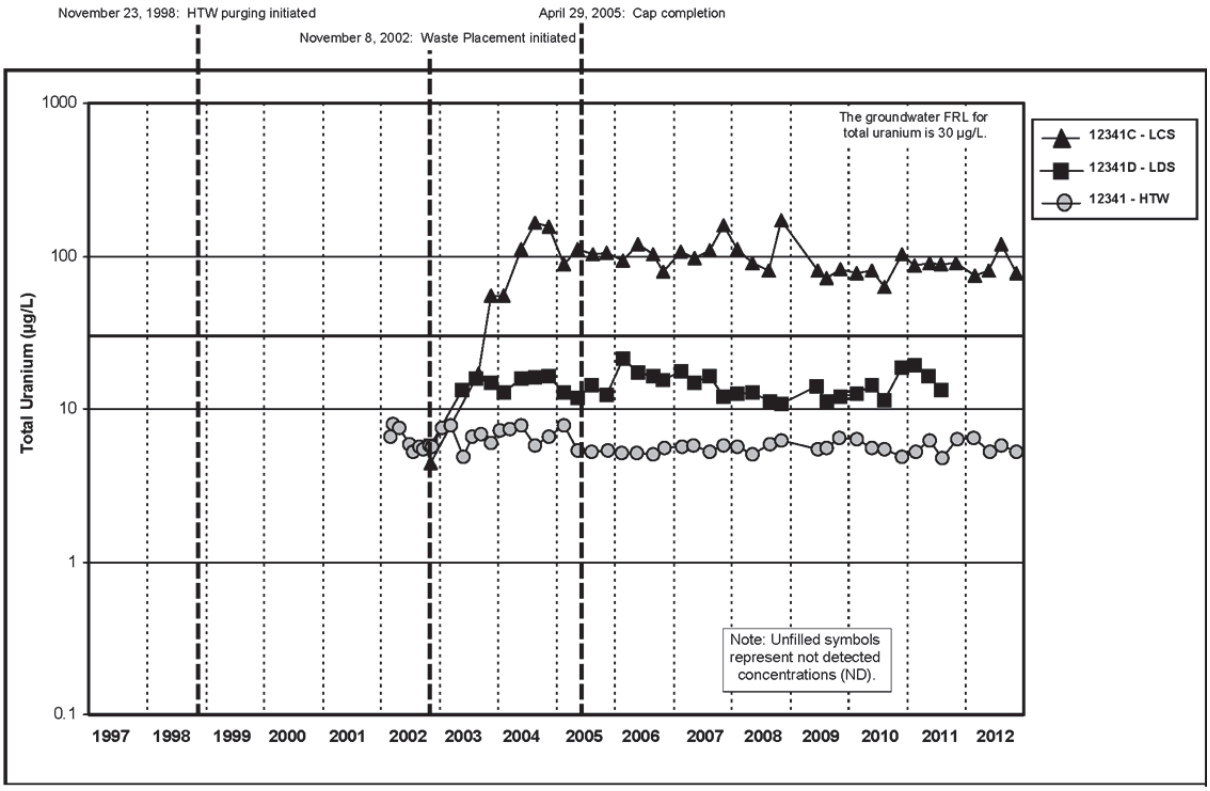


Figure A.5.4–6A. Cell 4 Uranium, Total Concentration vs. Time Plot for LCS, LDS, and HTW

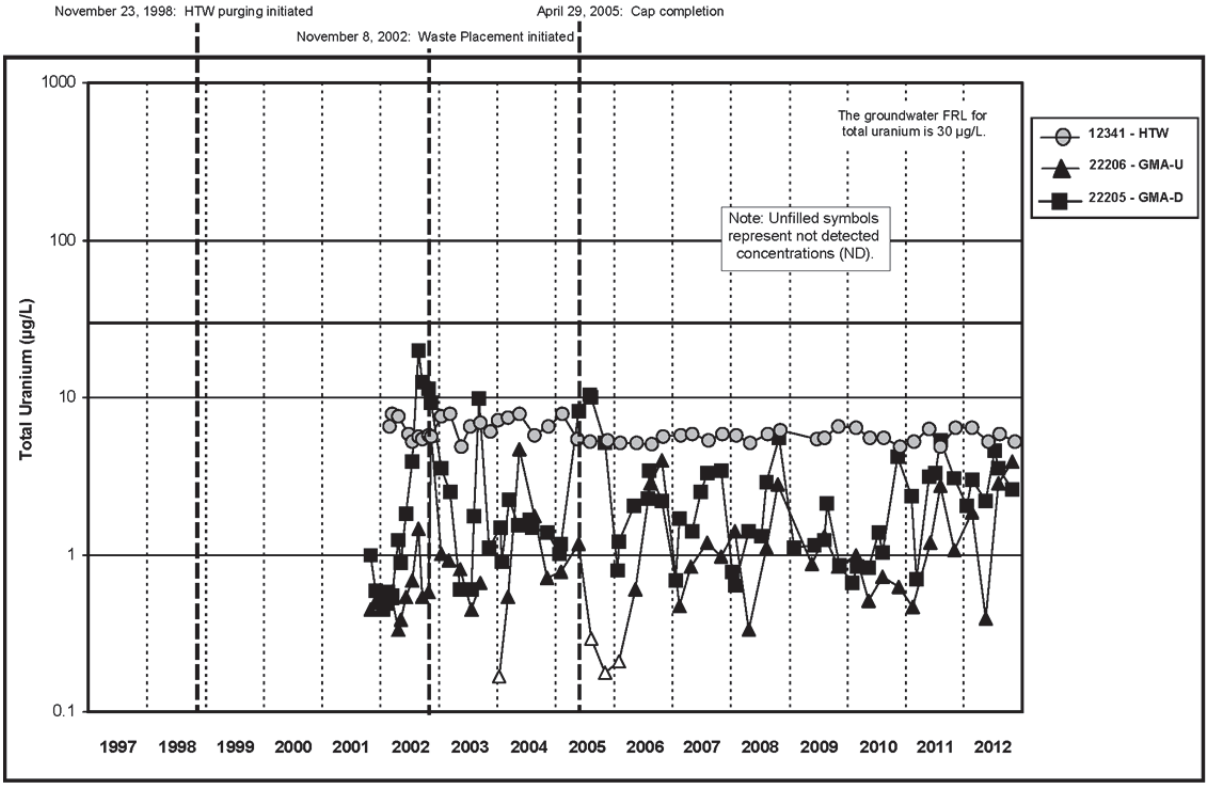


Figure A.5.4–6B. Cell 4 Uranium, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

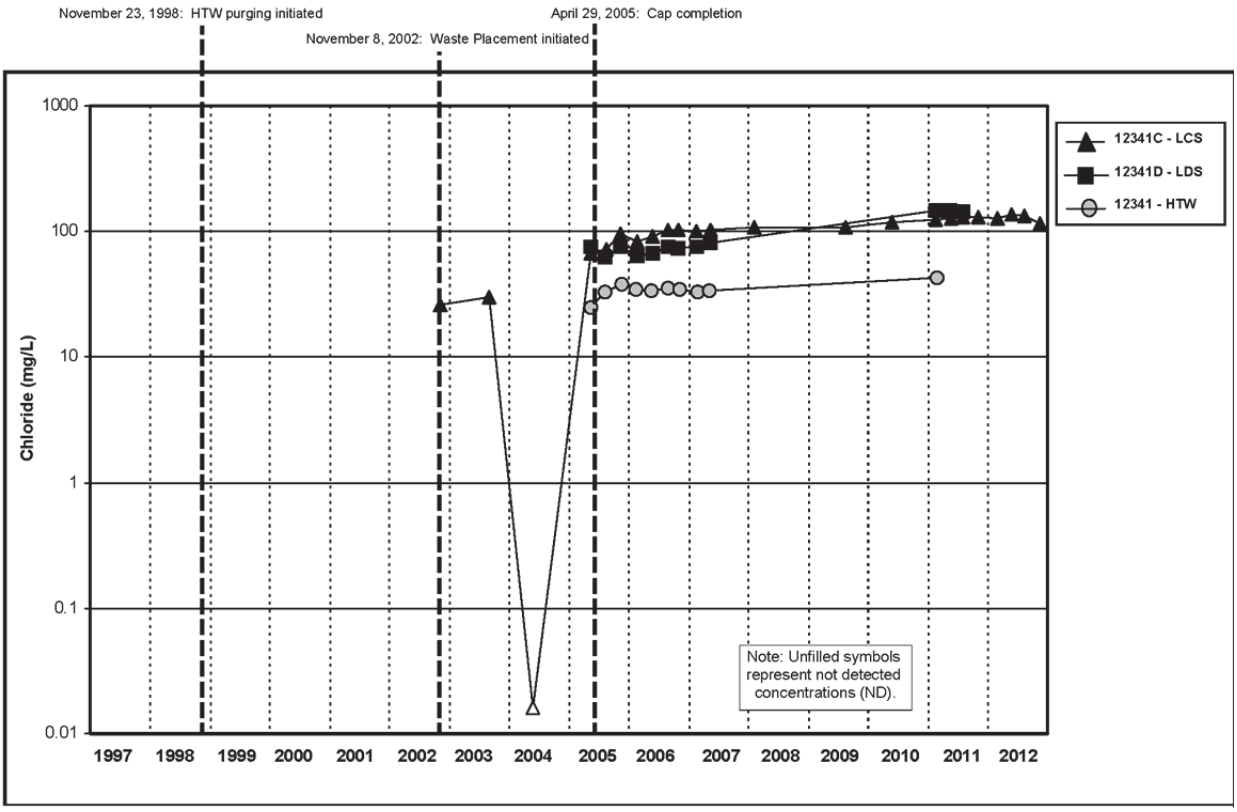


Figure A.5.4–7A. Cell 4 Chloride Concentration vs. Time Plot for LCS, LDS, and HTW

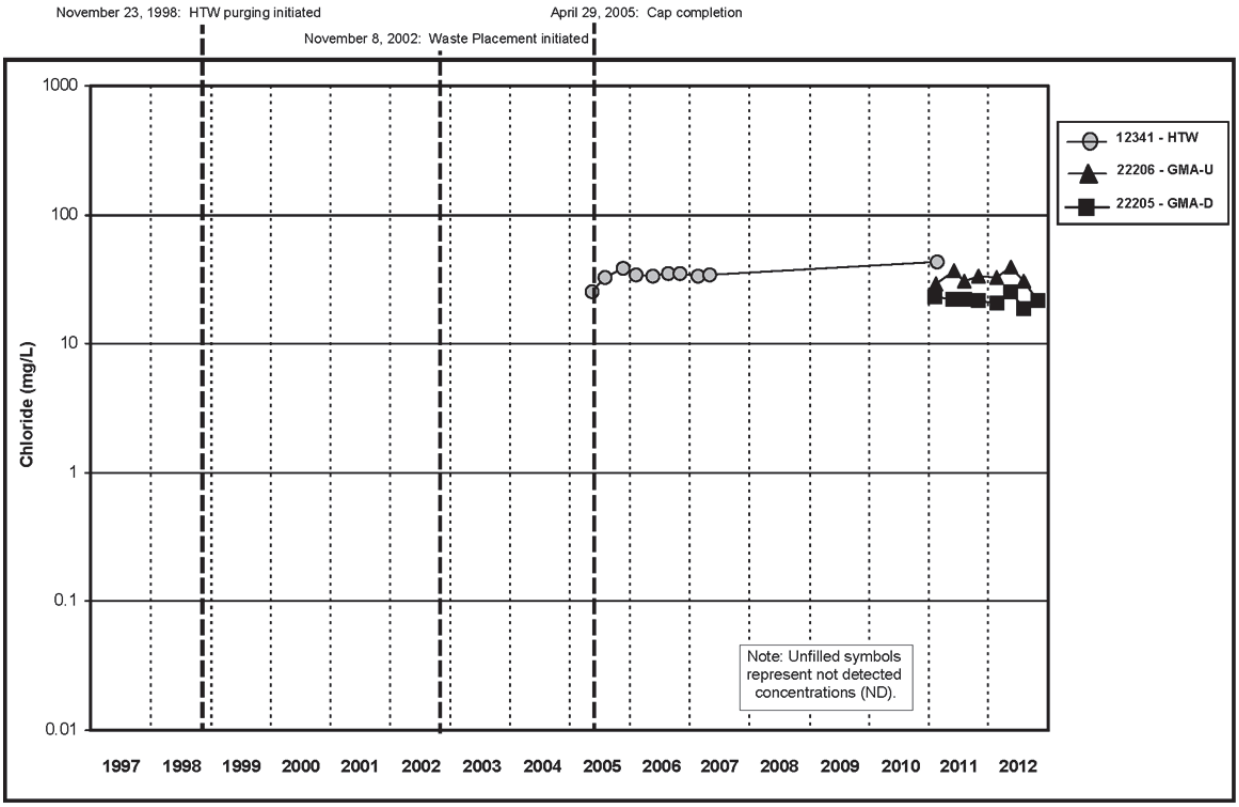


Figure A.5.4–7B. Cell 4 Chloride Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

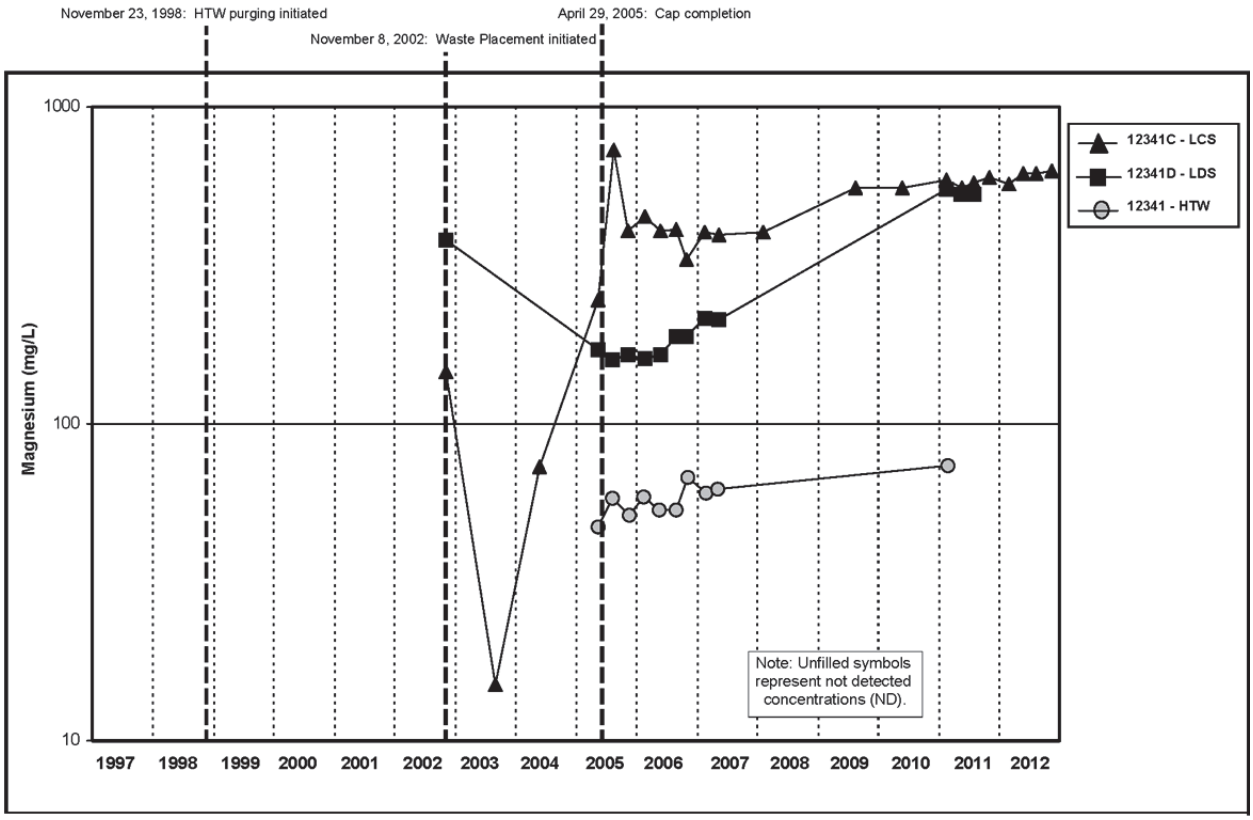


Figure A.5.4–8A. Cell 4 Magnesium Concentration vs. Time Plot for LCS, LDS, and HTW

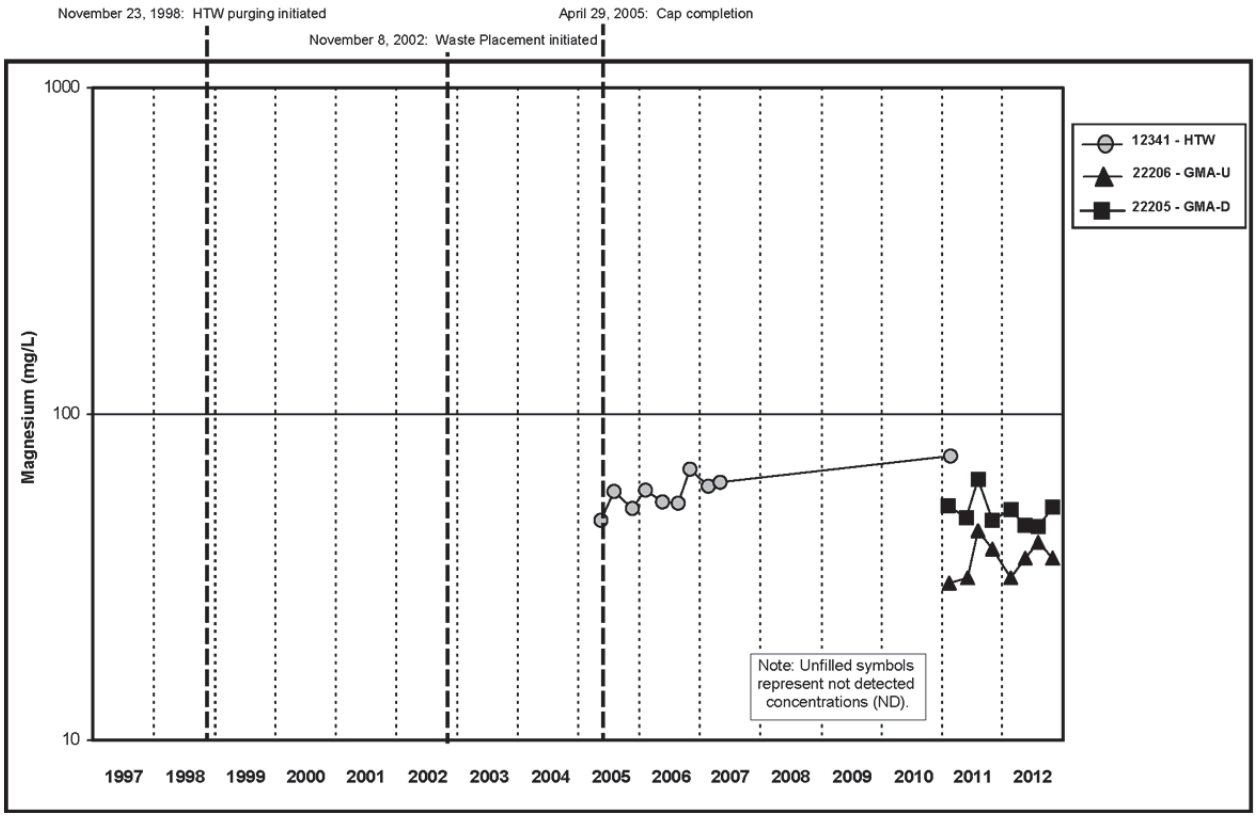


Figure A.5.4–8B. Cell 4 Magnesium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

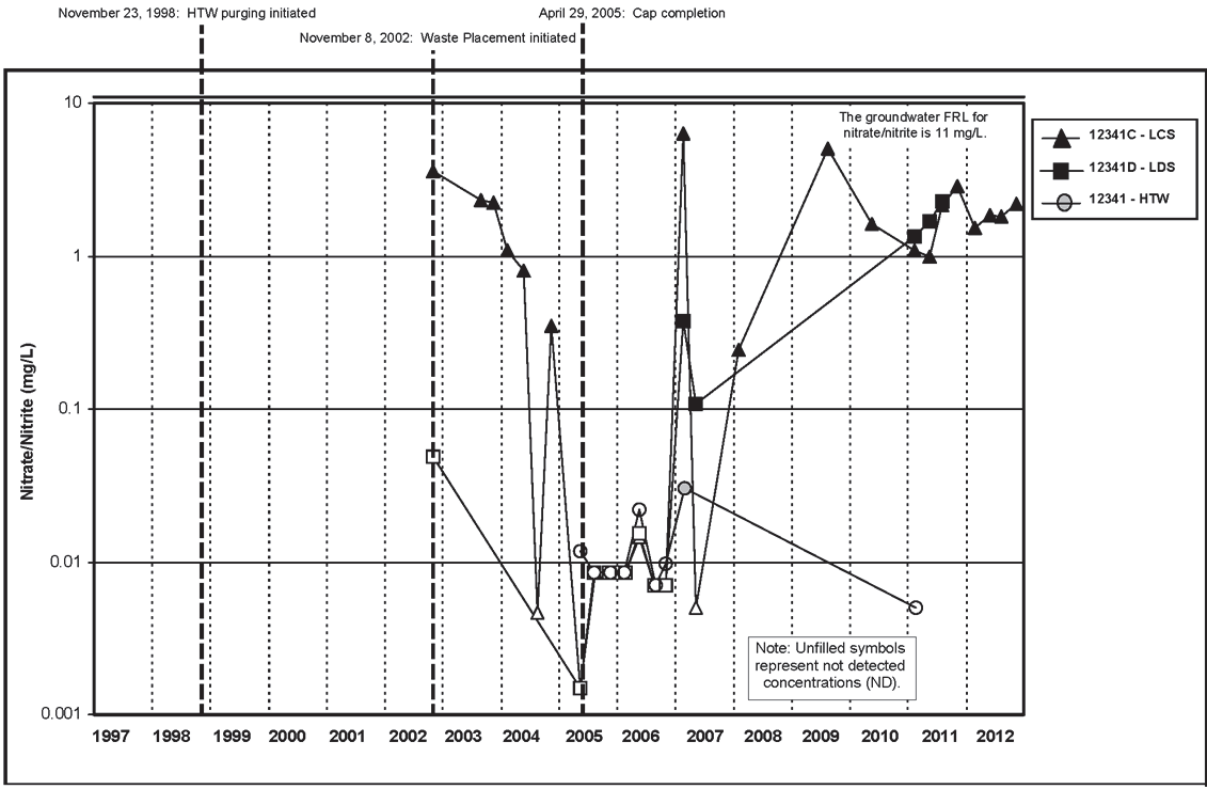


Figure A.5.4–9A. Cell 4 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for LCS, LDS, and HTW

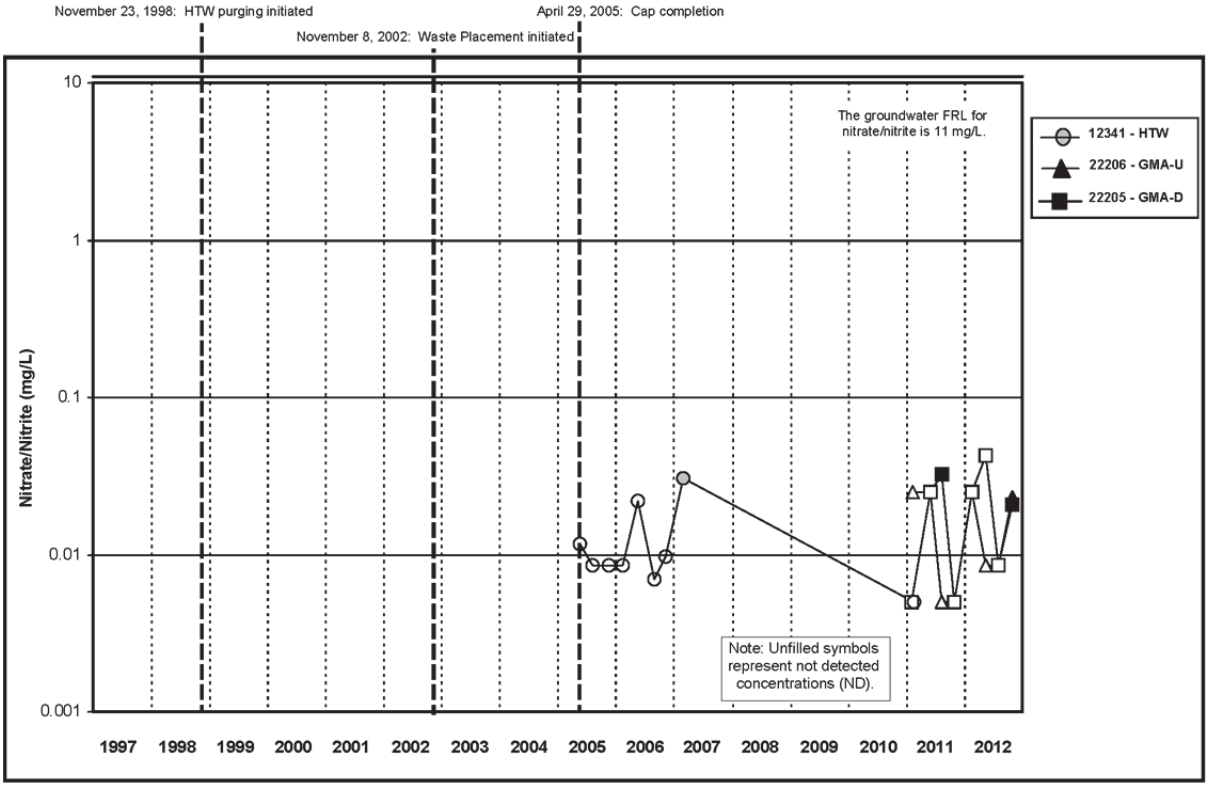


Figure A.5.4–9B. Cell 4 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

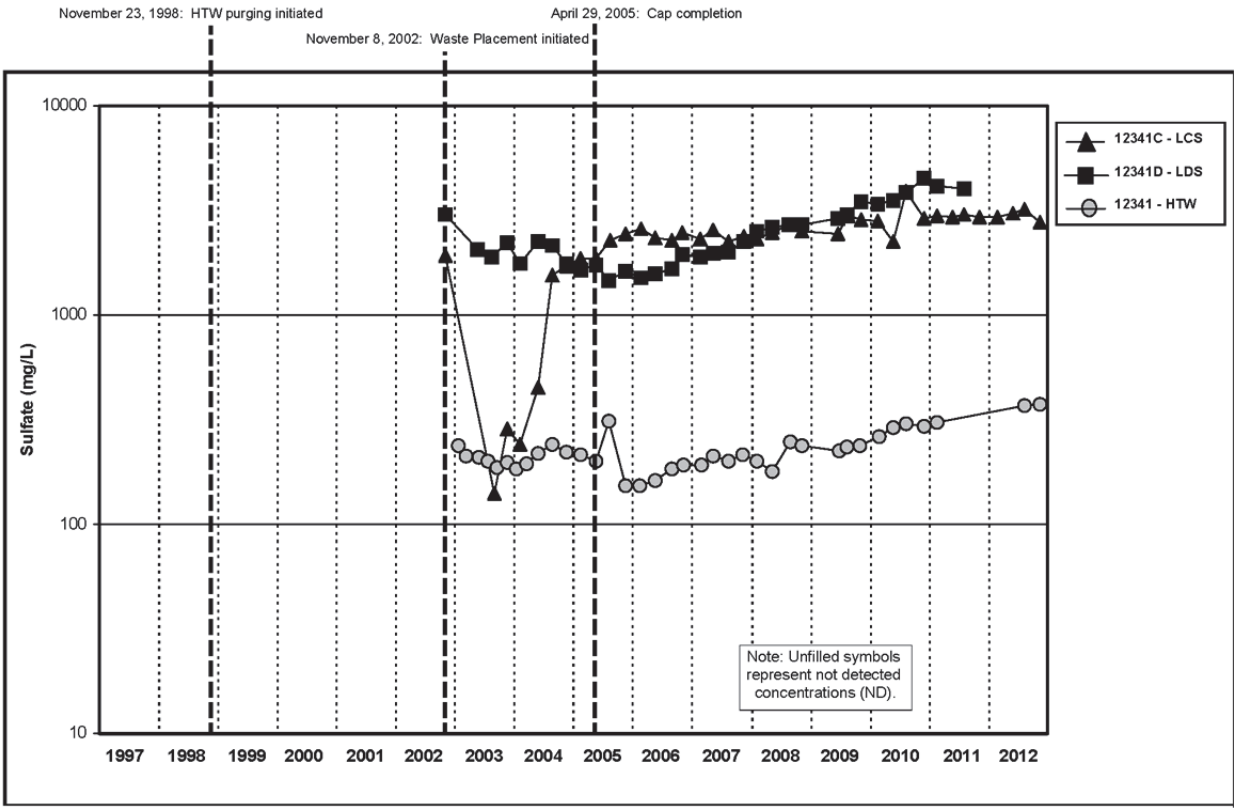


Figure A.5.4–10A. Cell 4 Sulfate Concentration vs. Time Plot for LCS, LDS, and HTW

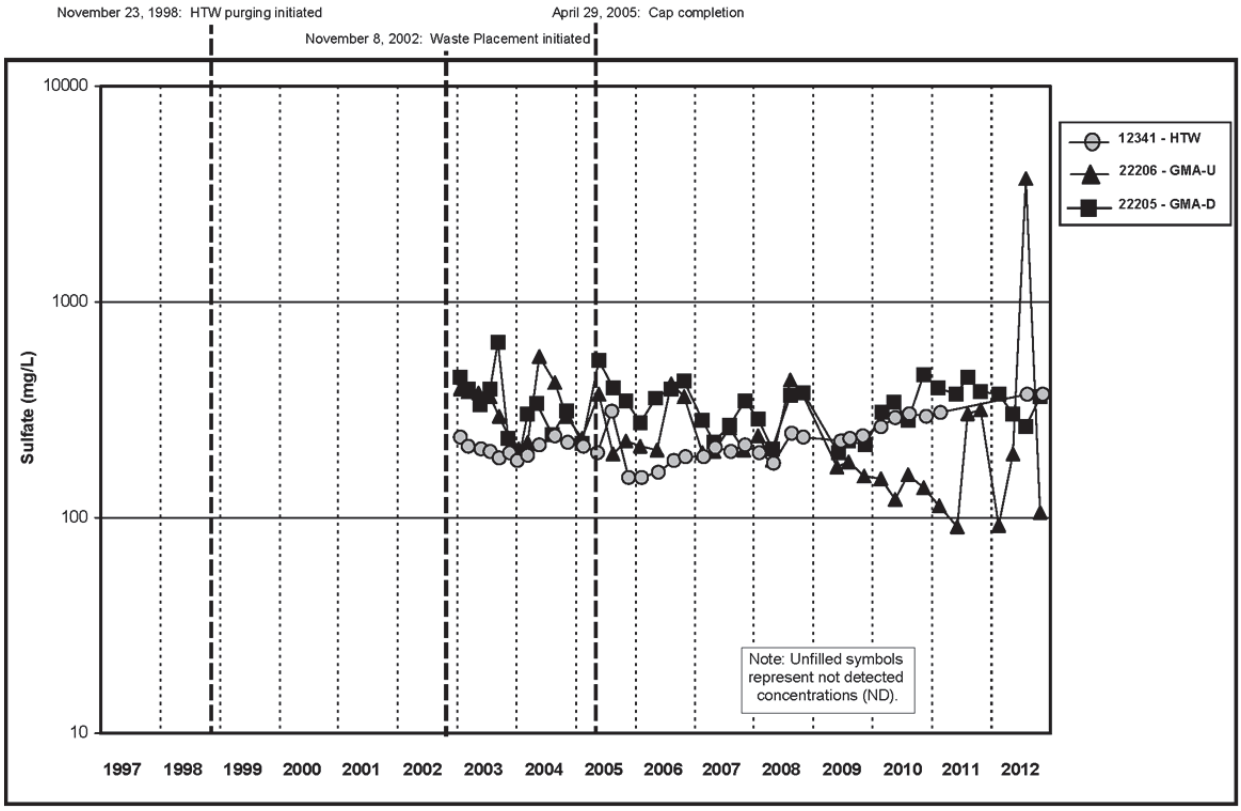


Figure A.5.4–10B. Cell 4 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

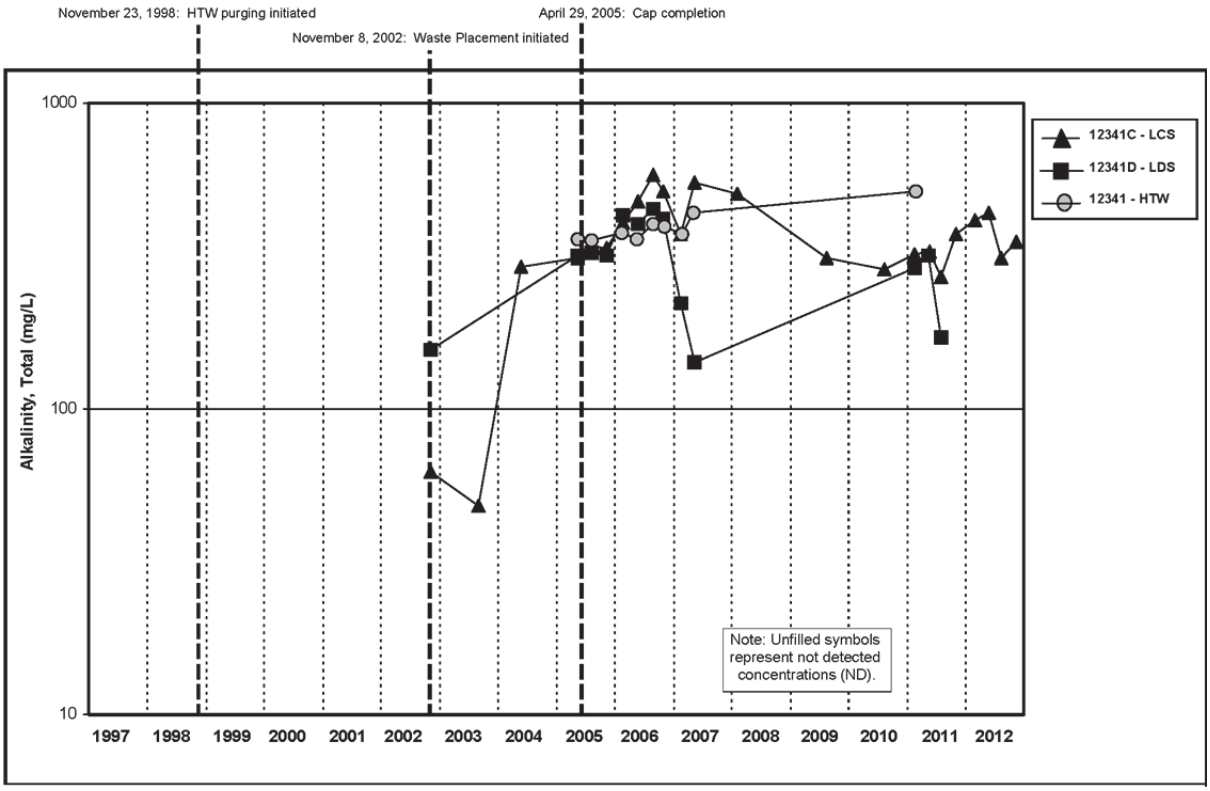


Figure A.5.4–11A. Cell 4 Alkalinity, Total Concentration vs. Time Plot for LCS, LDS, and HTW

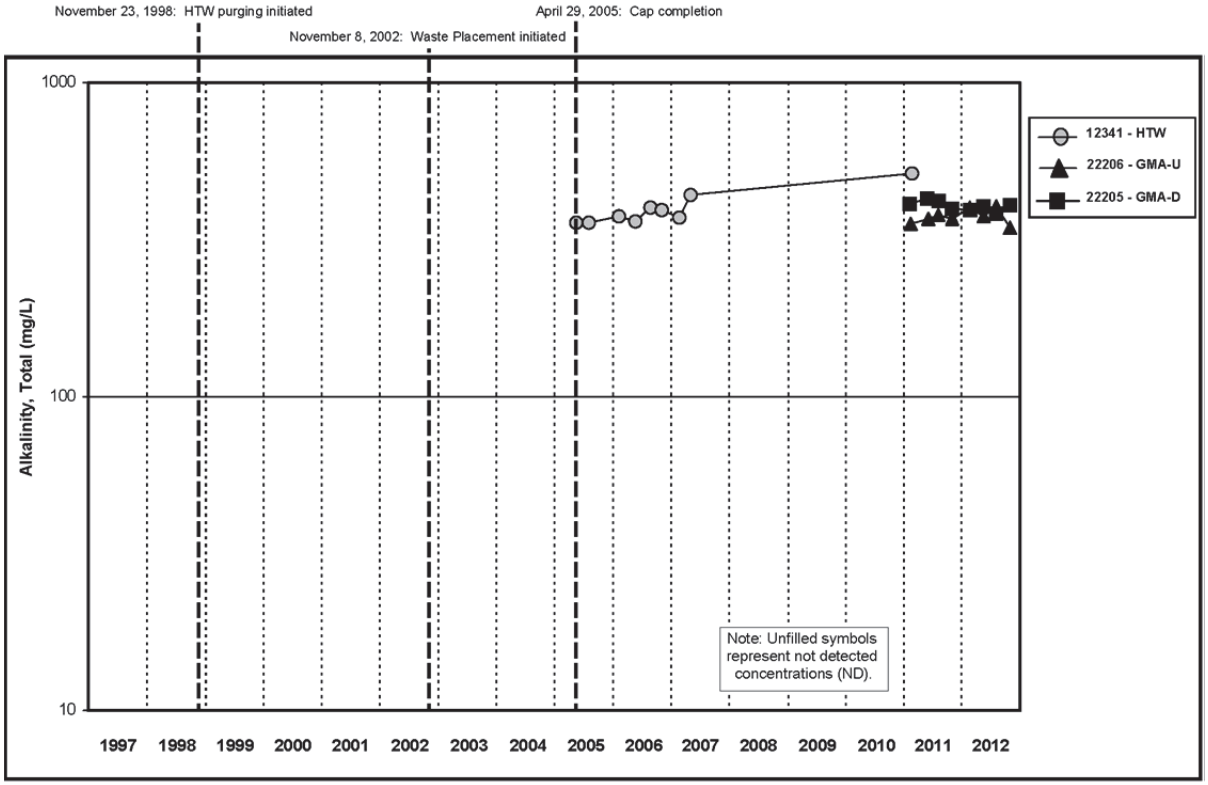


Figure A.5.4–11B. Cell 4 Alkalinity, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

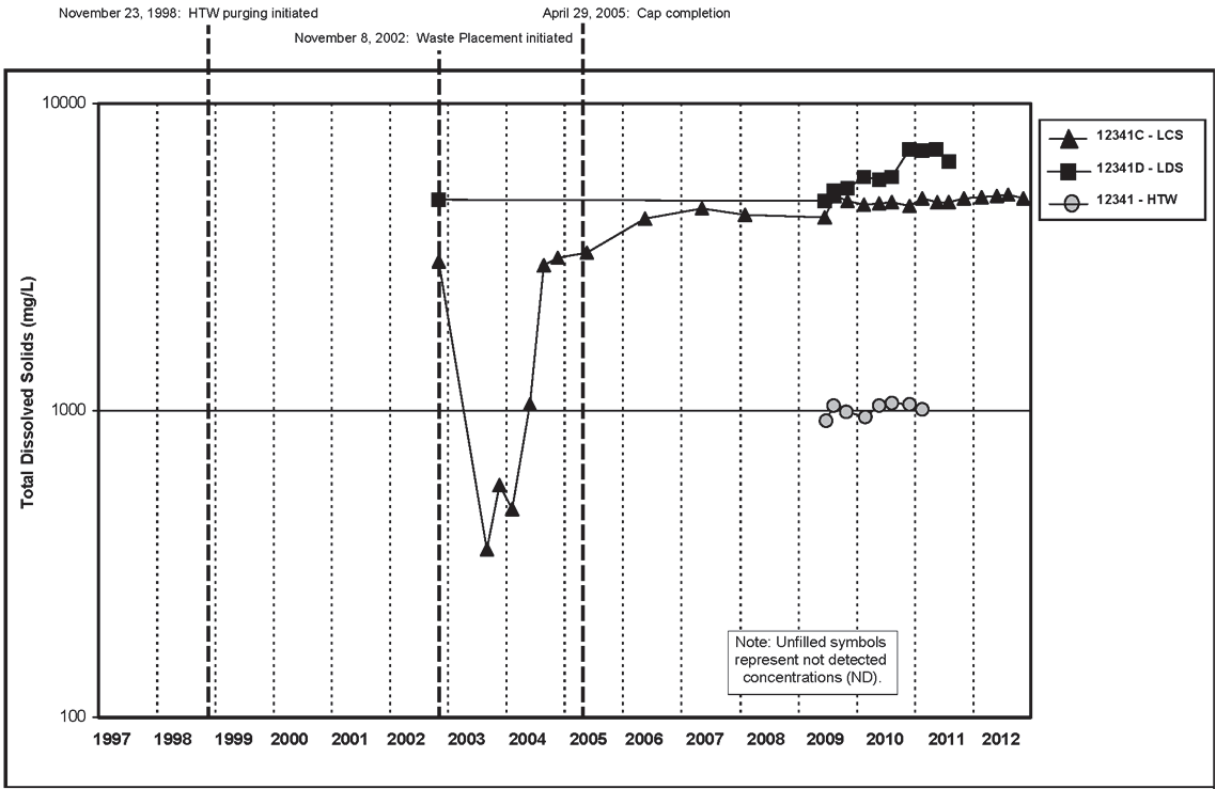


Figure A.5.4–12A. Cell 4 Total Dissolved Solids Concentration vs. Time Plot for LCS, LDS, and HTW

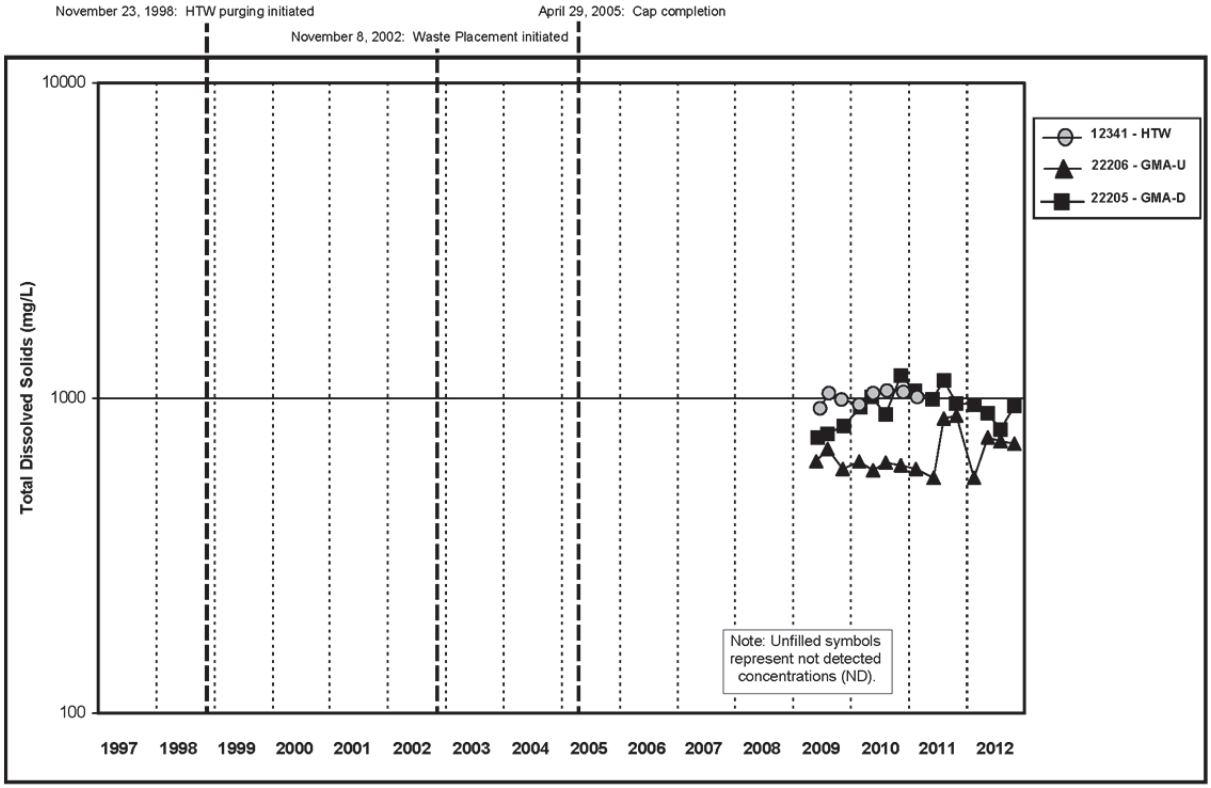


Figure A.5.4–12B. Cell 4 Total Dissolved Solids Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

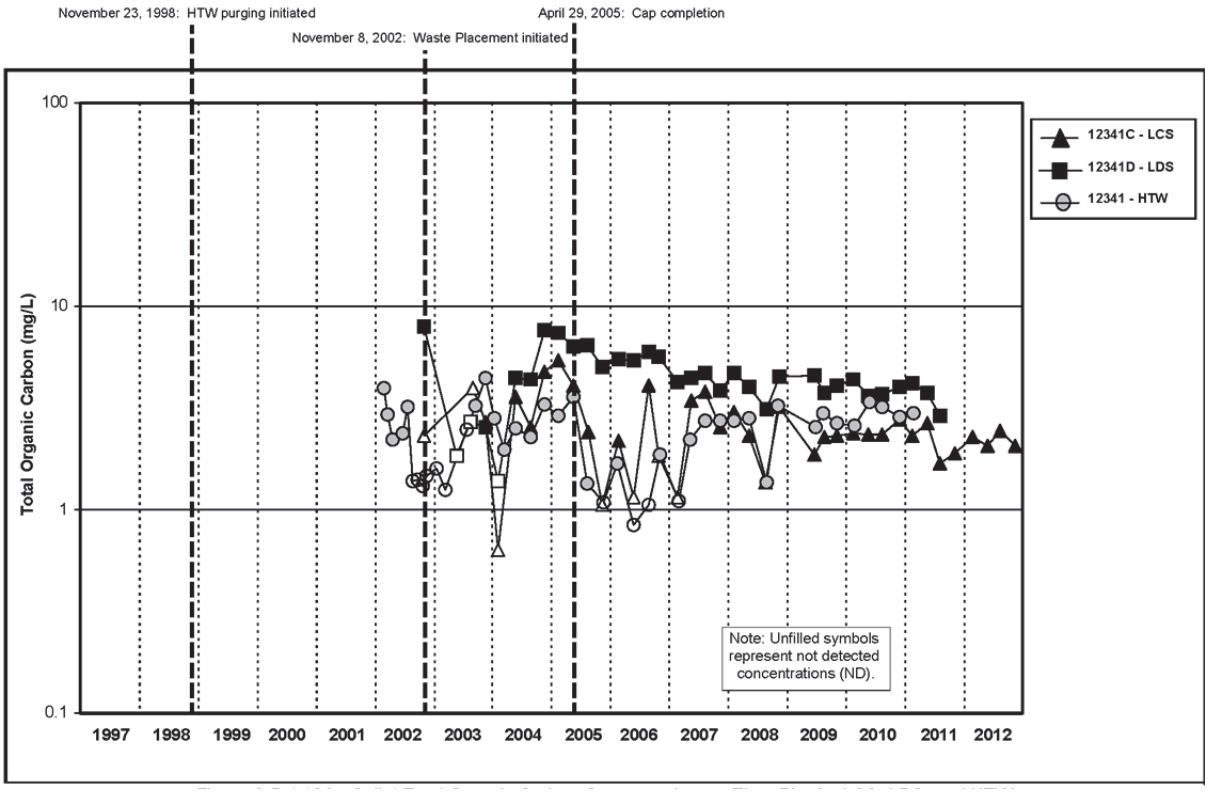


Figure A.5.4–13A. Cell 4 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, and HTW

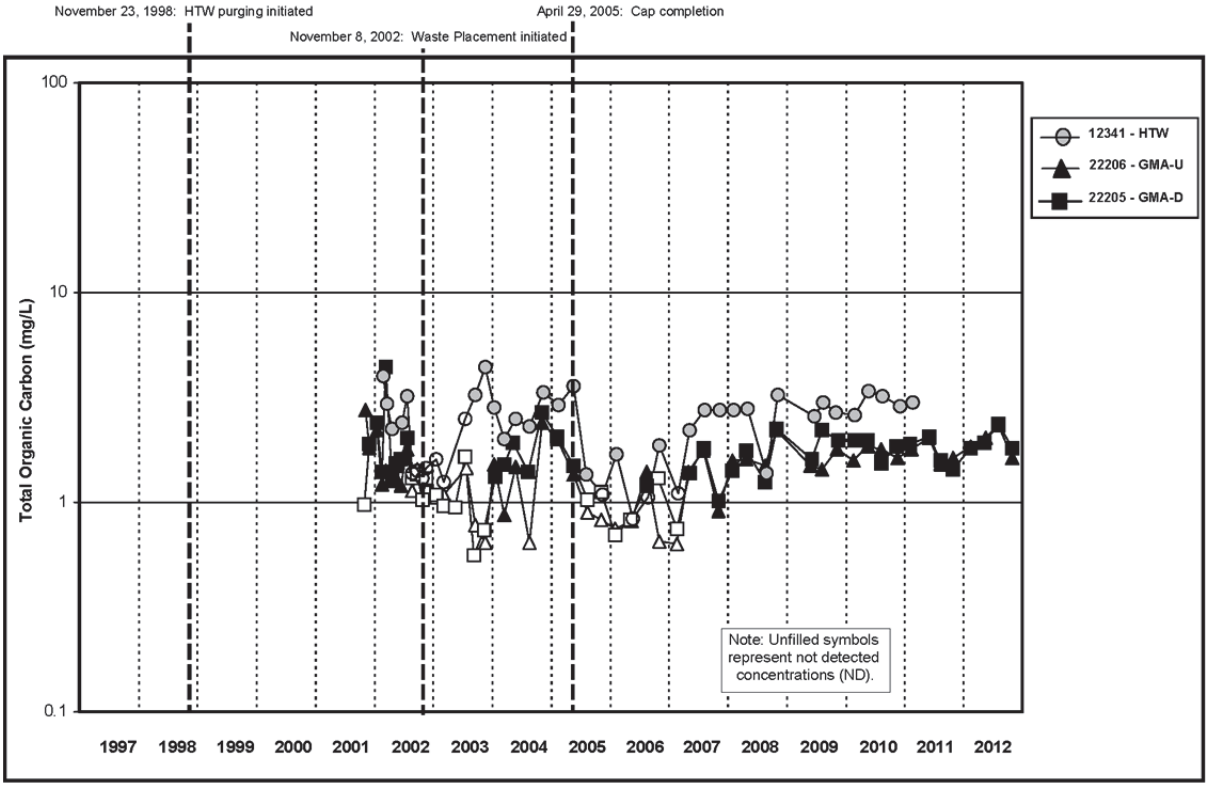


Figure A.5.4–13B. Cell 4 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

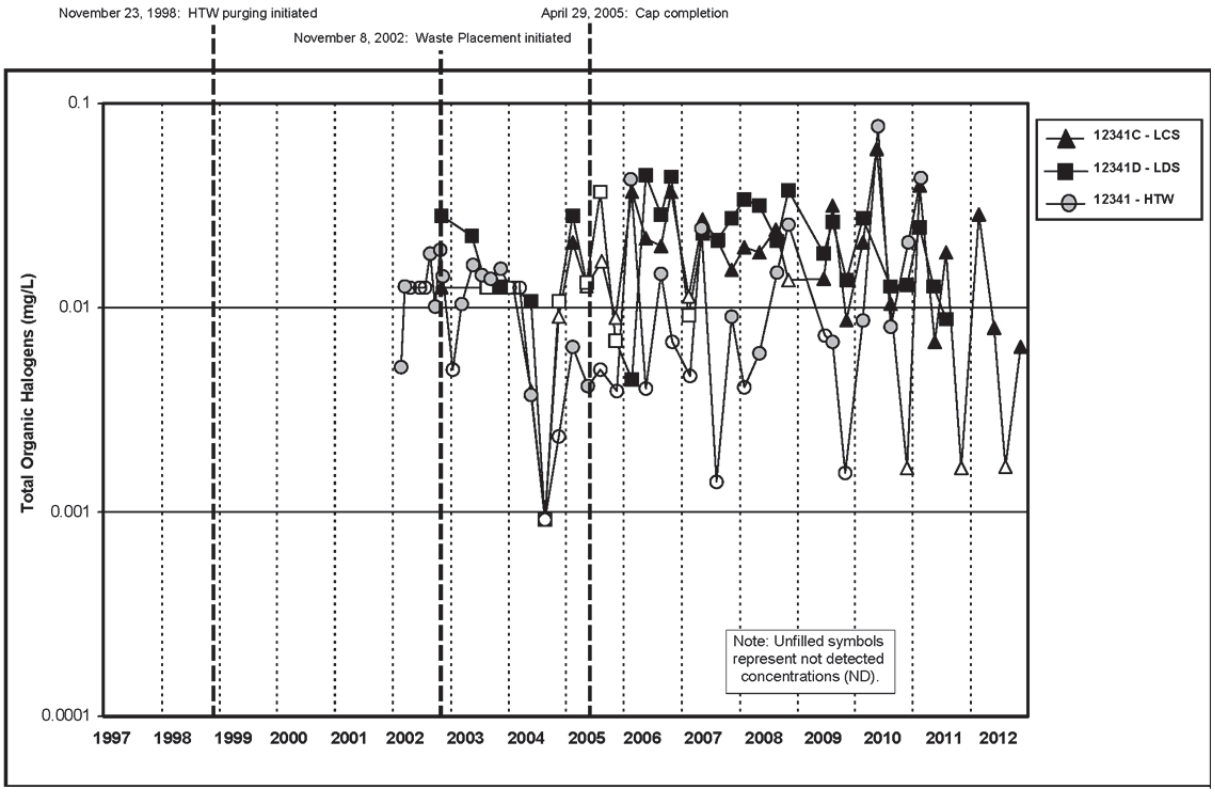


Figure A.5.4–14A. Cell 4 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, and HTW

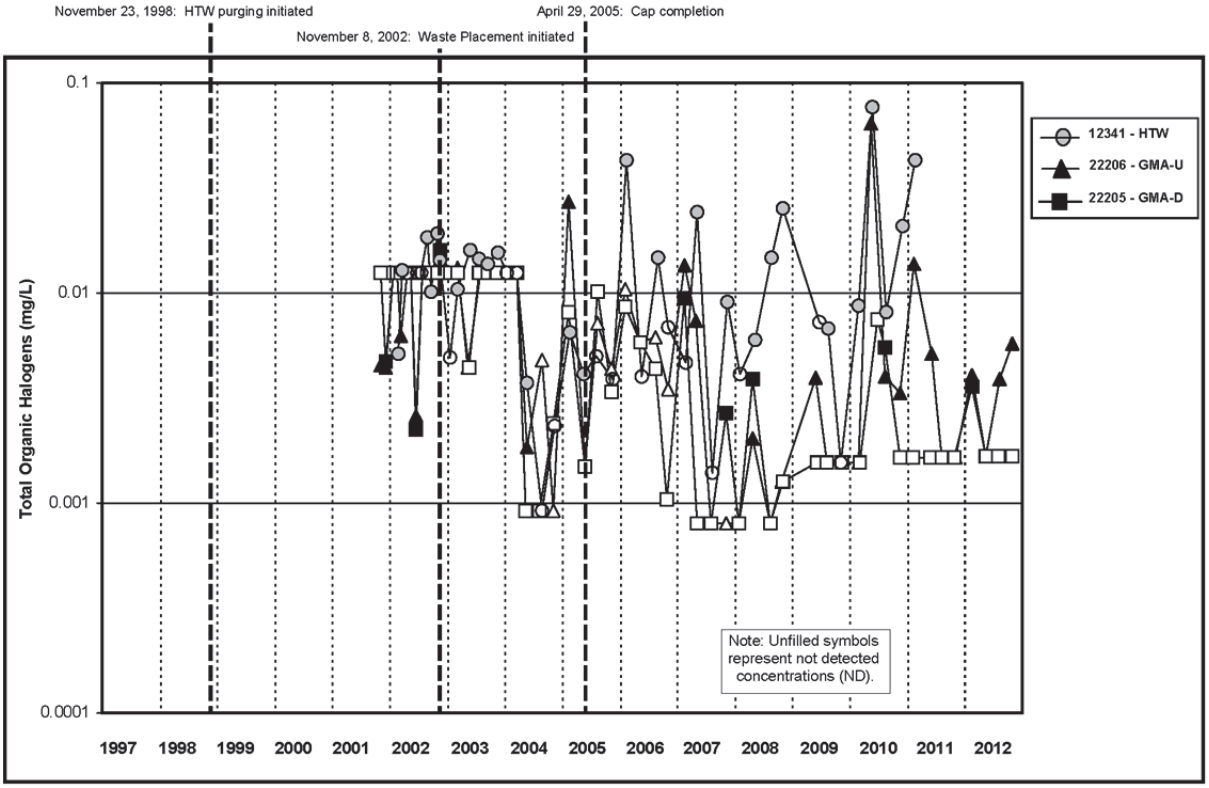


Figure A.5.4–14B. Cell 4 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

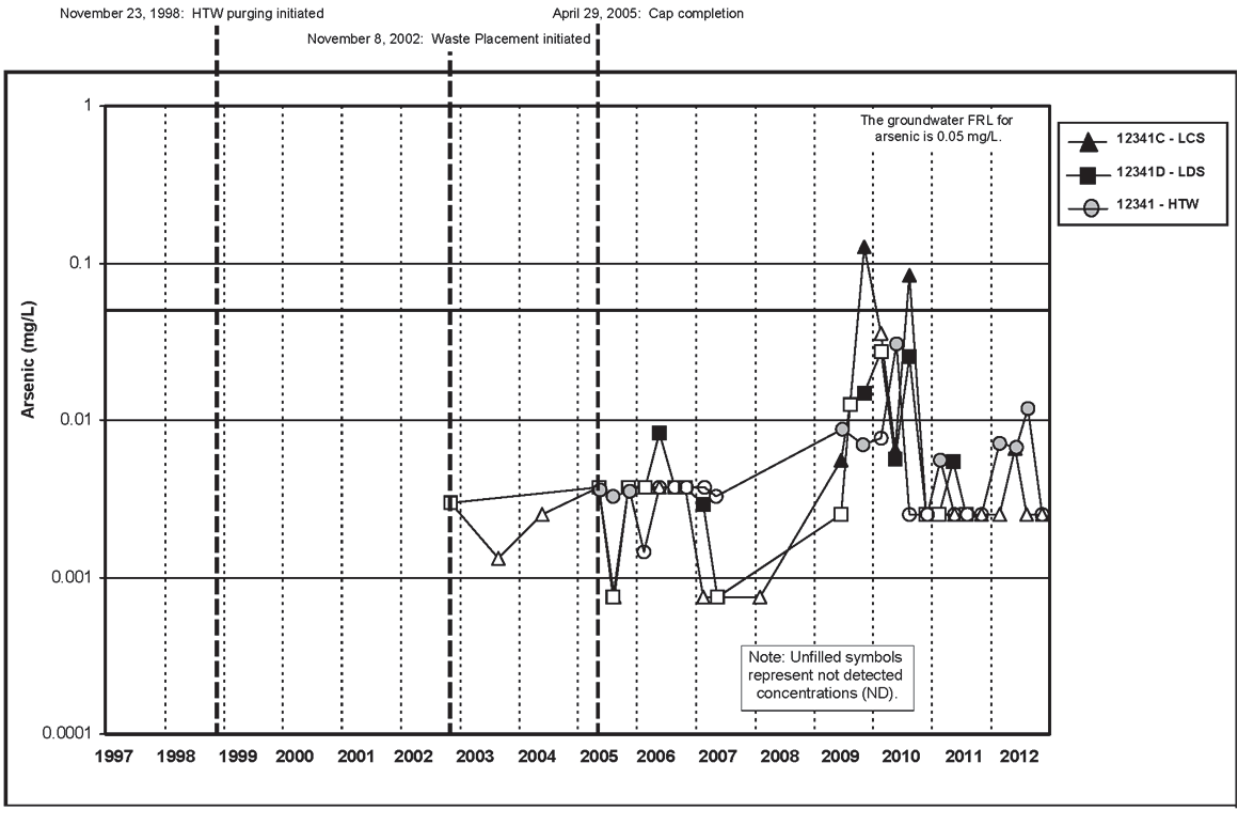


Figure A.5.4–15A. Cell 4 Arsenic Concentration vs. Time Plot for LCS, LDS, and HTW

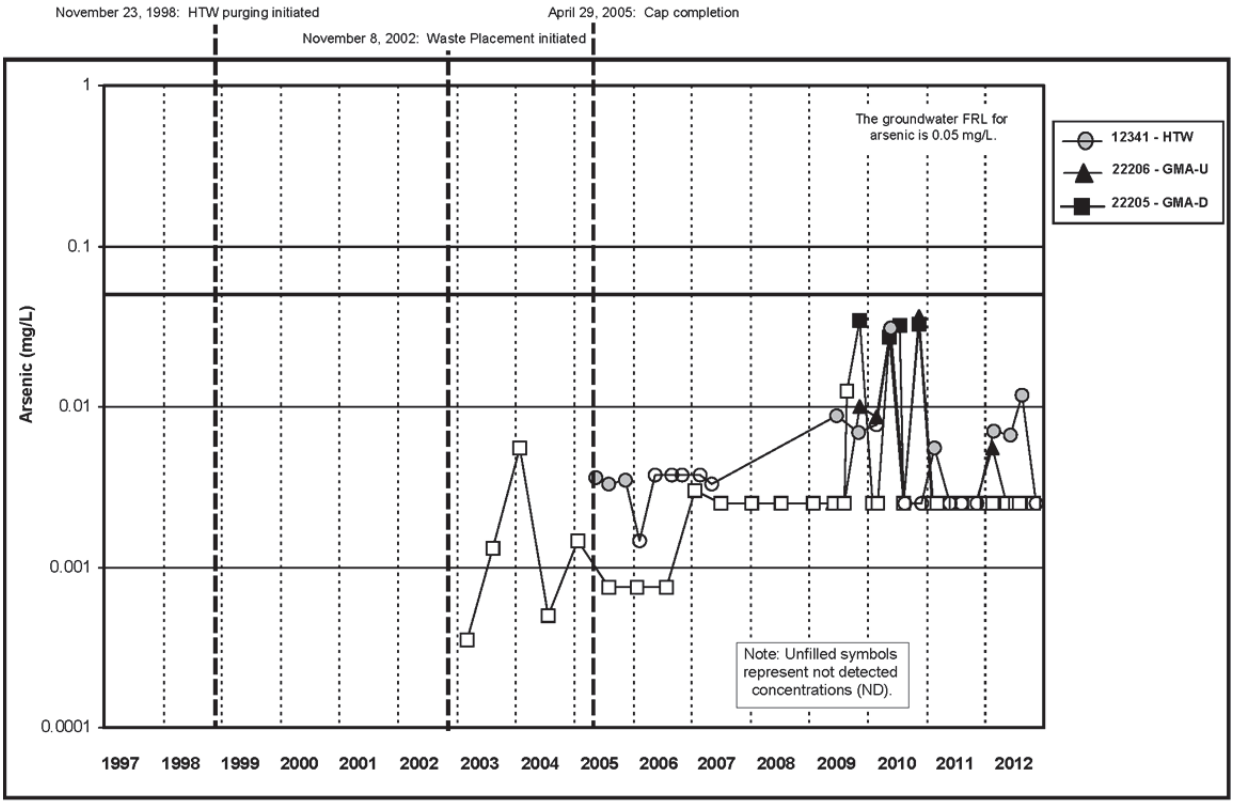


Figure A.5.4–15B. Cell 4 Arsenic Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

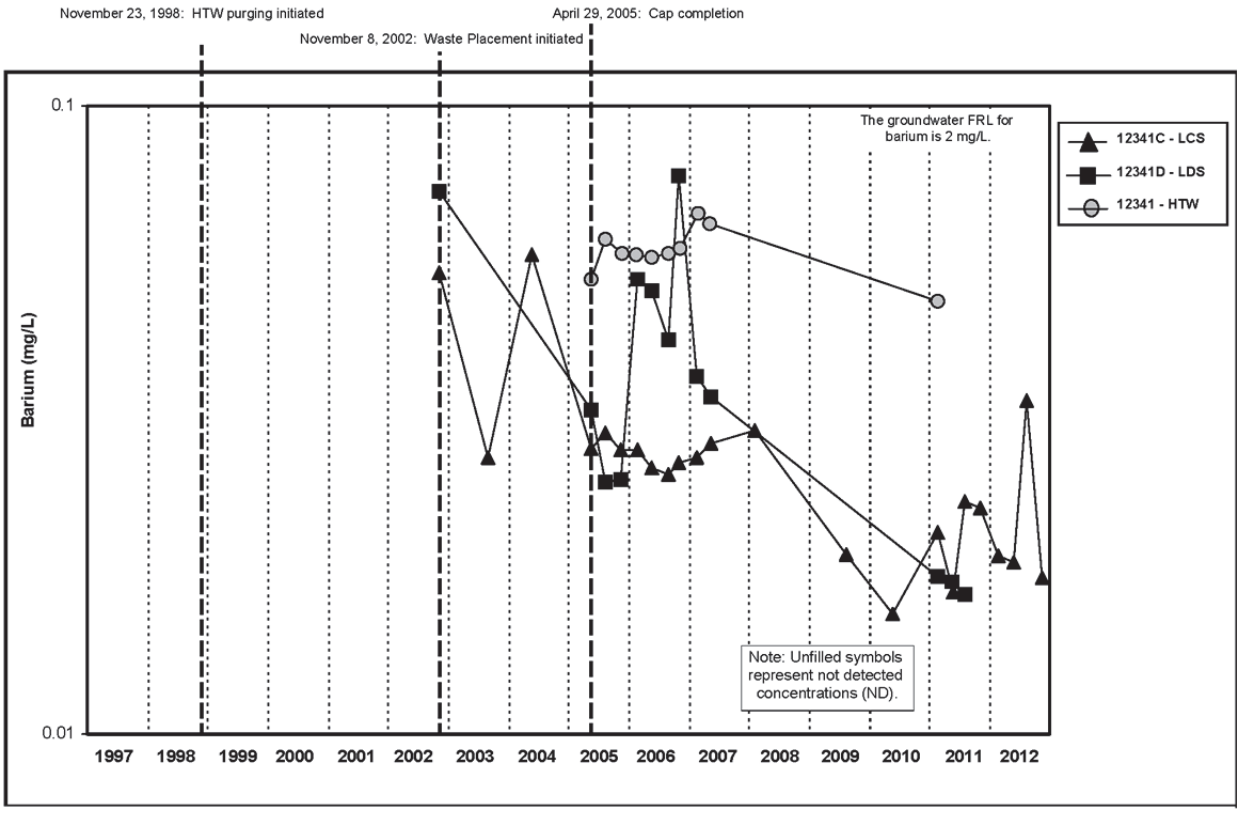


Figure A.5.4–16A. Cell 4 Barium Concentration vs. Time Plot for LCS, LDS, and HTW

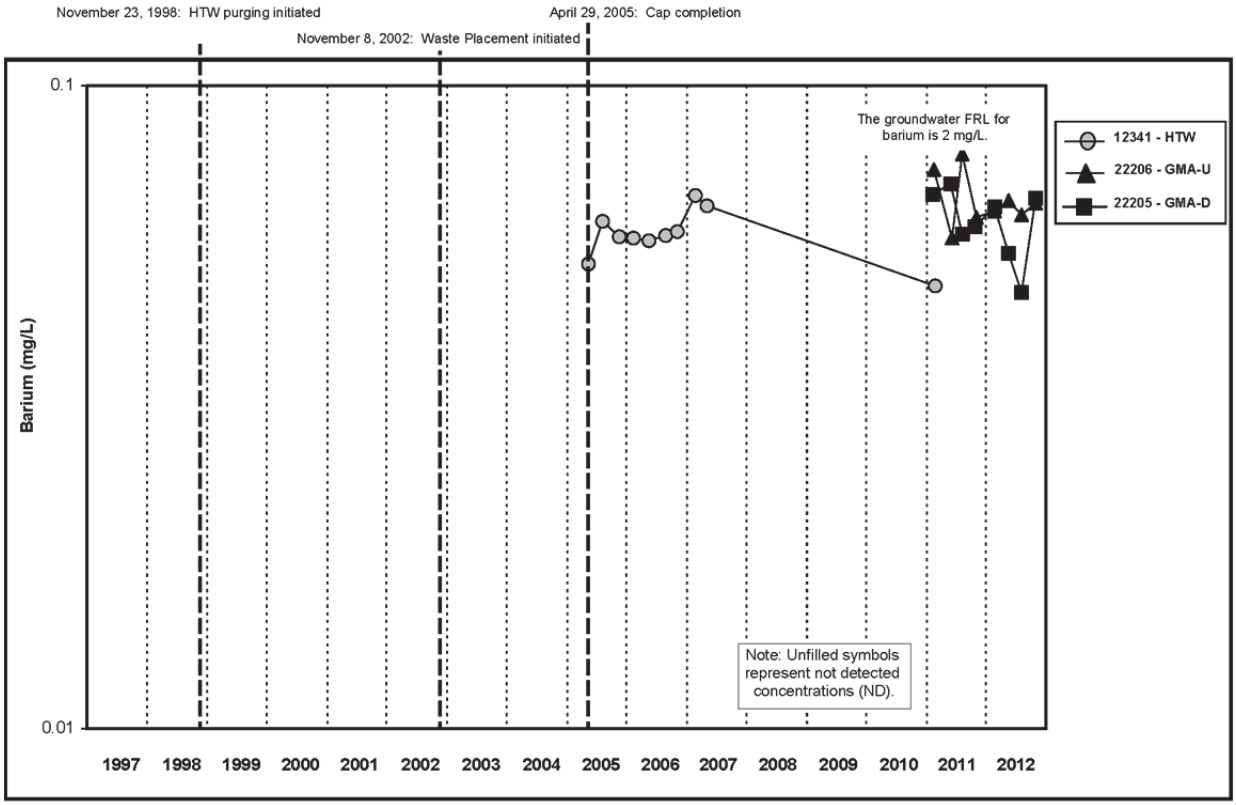


Figure A.5.4–16B. Cell 4 Barium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

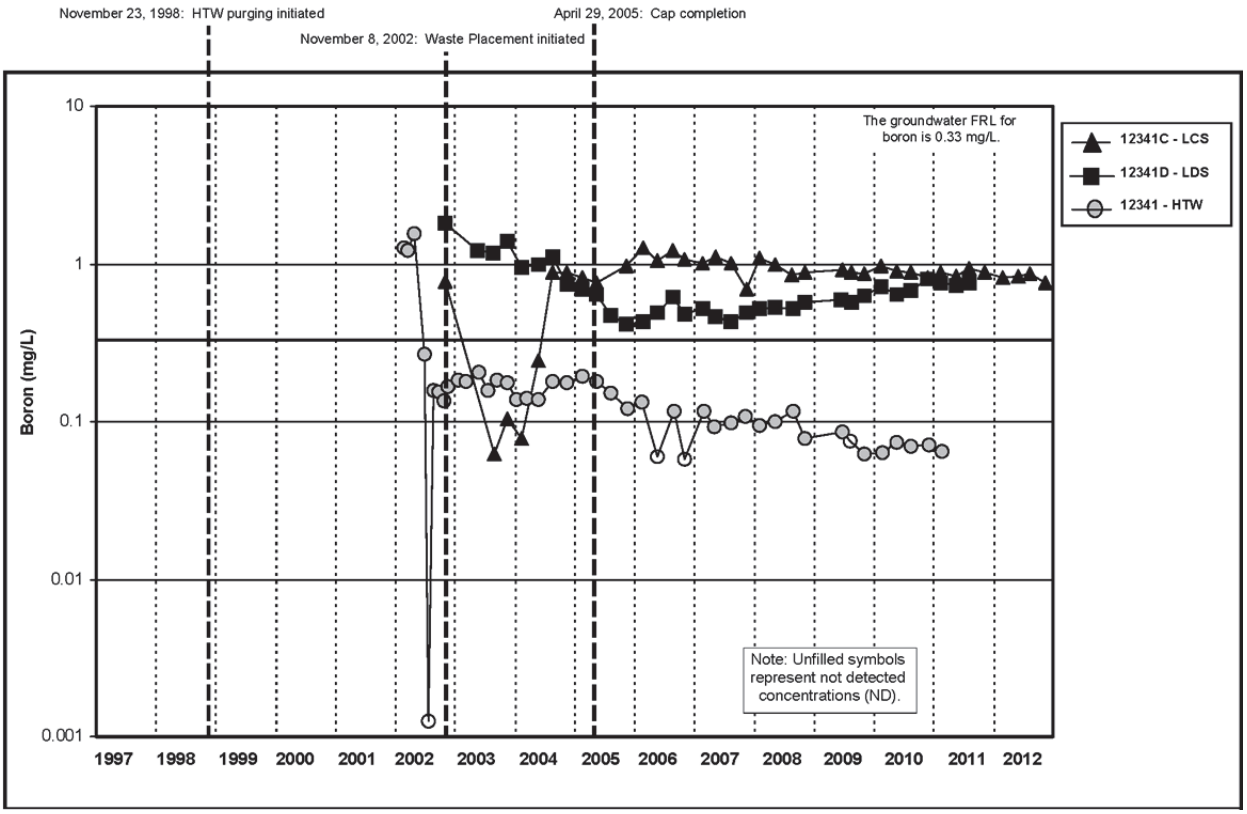


Figure A.5.4–17A. Cell 4 Boron Concentration vs. Time Plot for LCS, LDS, and HTW

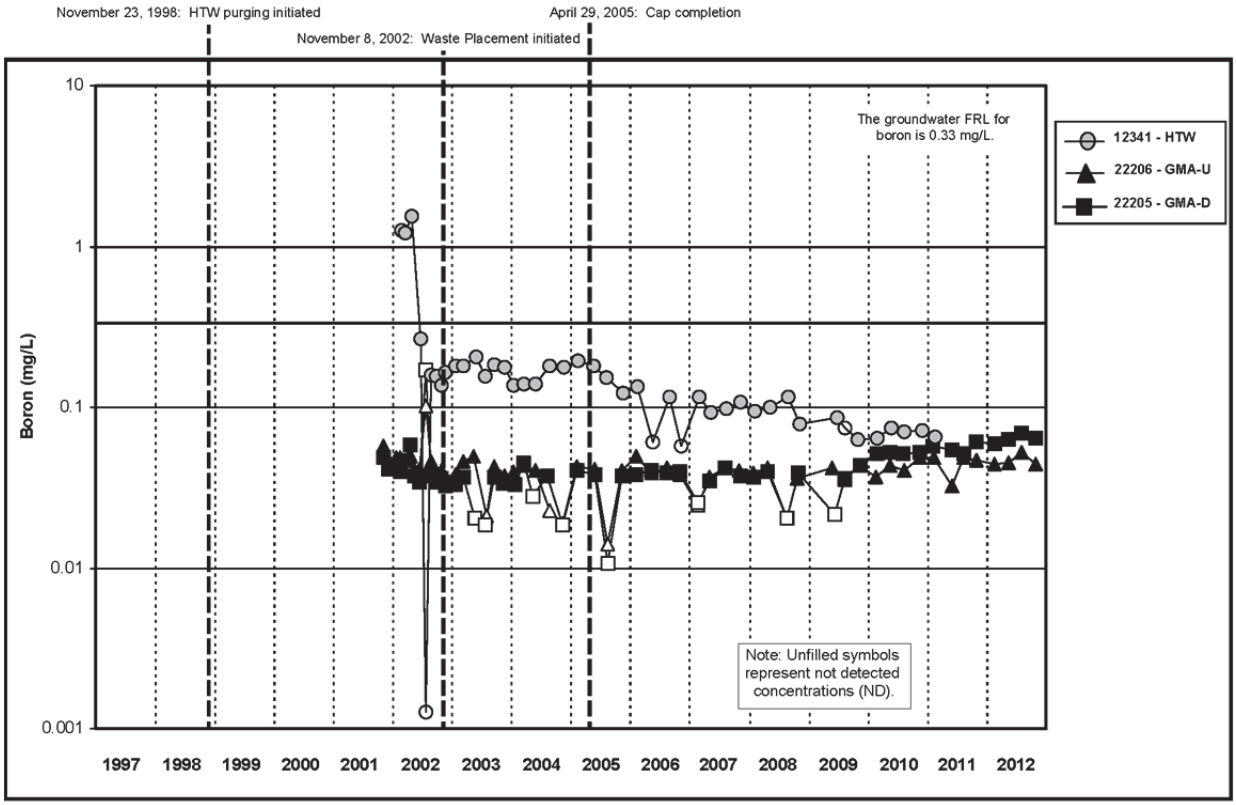


Figure A.5.4–17B. Cell 4 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

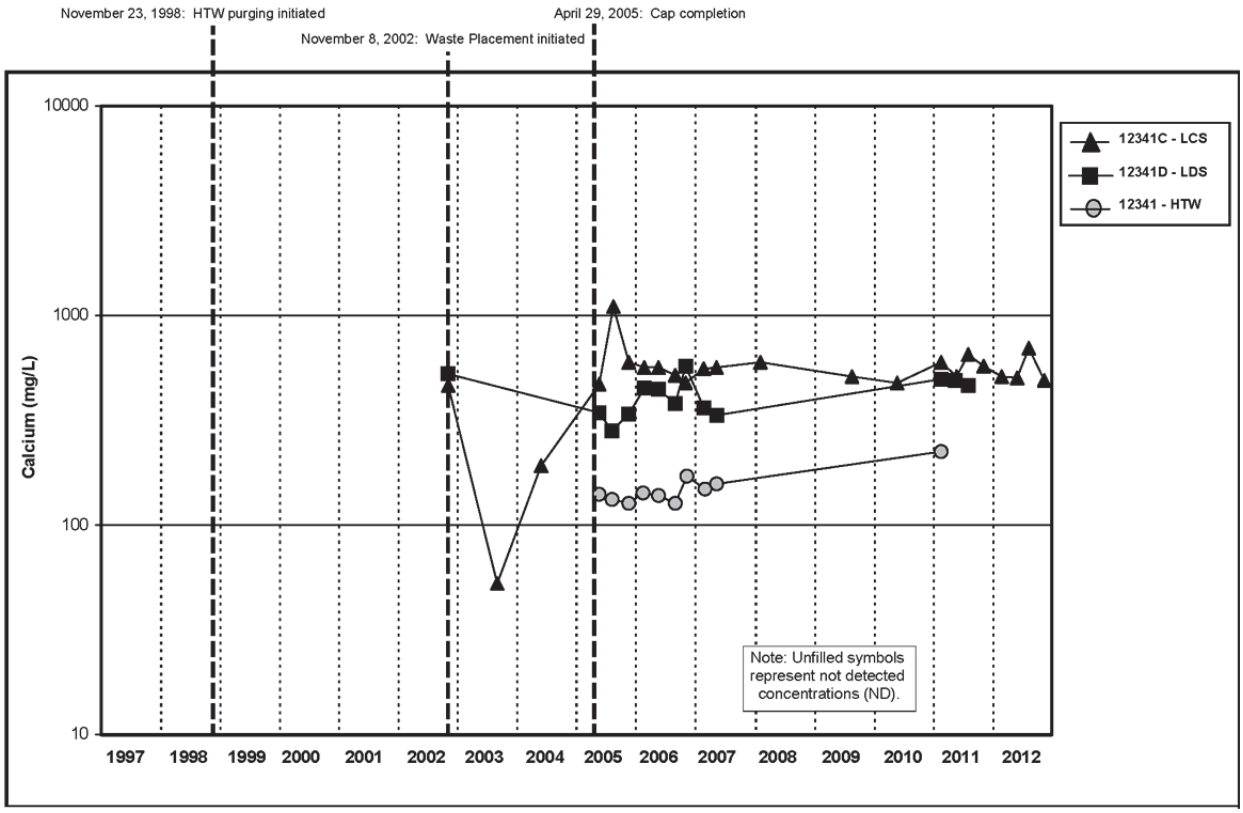


Figure A.5.4–18A. Cell 4 Calcium Concentration vs. Time Plot for LCS, LDS, and HTW

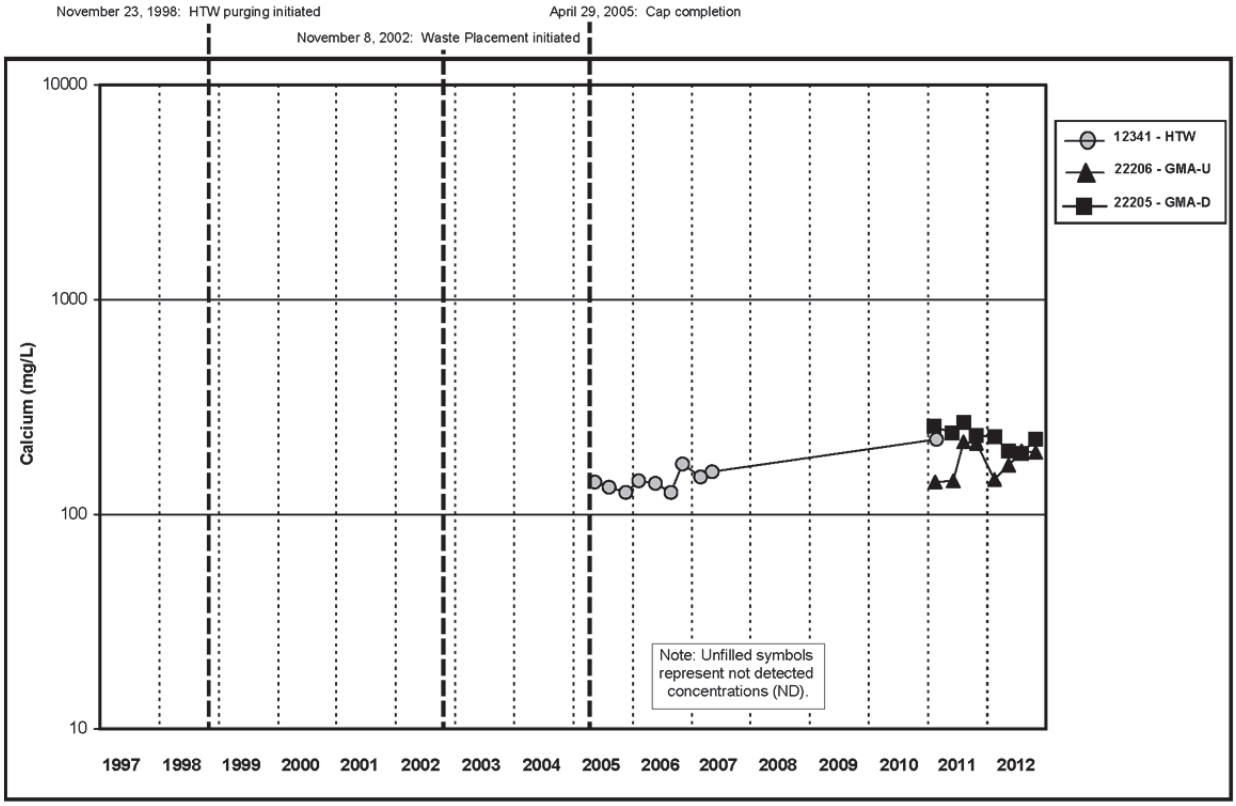


Figure A.5.4–18B. Cell 4 Calcium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

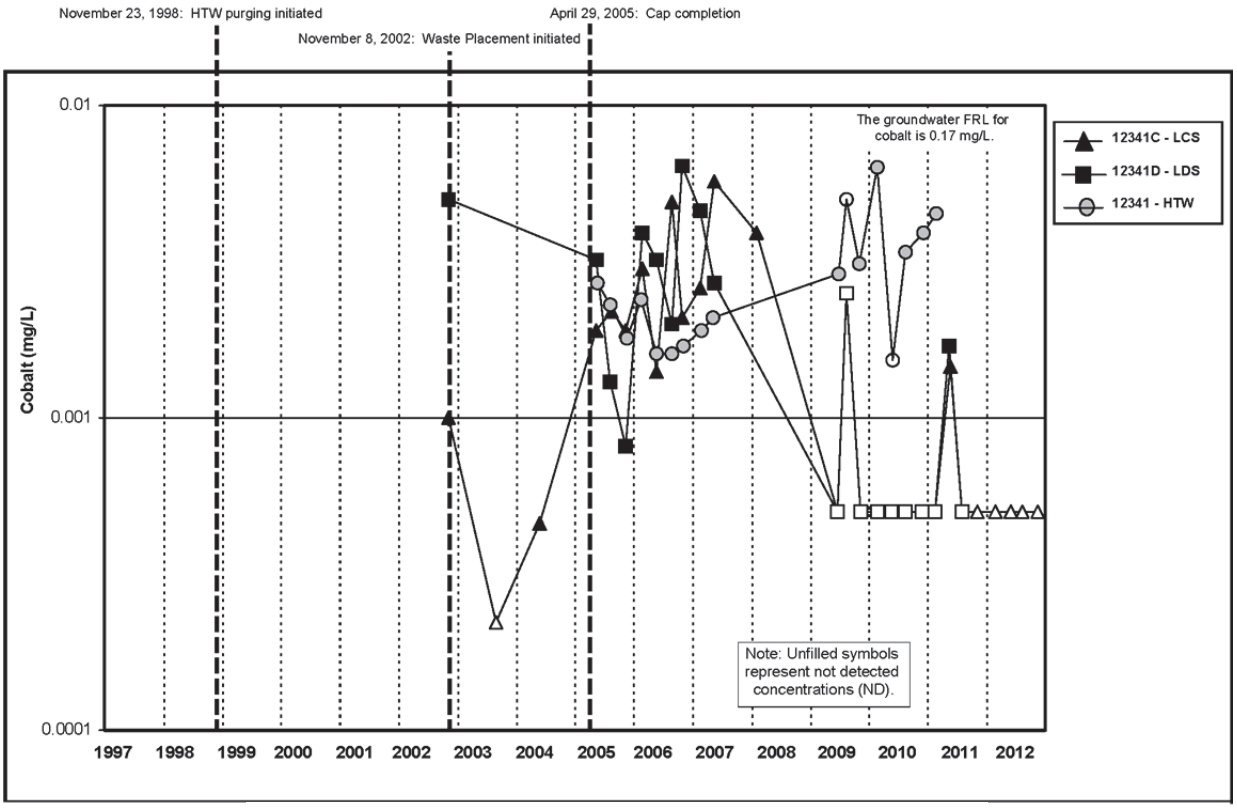


Figure A.5.4–19A. Cell 4 Cobalt Concentration vs. Time Plot for LCS, LDS, and HTW

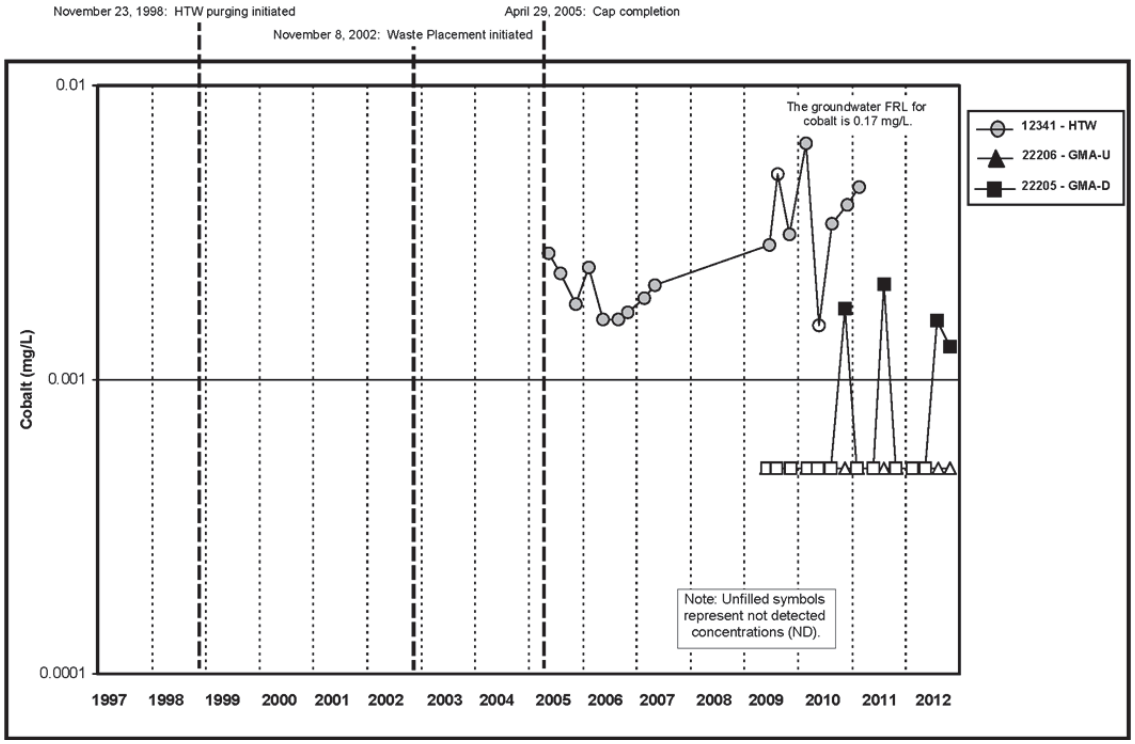


Figure A.5.4–19B. Cell 4 Cobalt Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

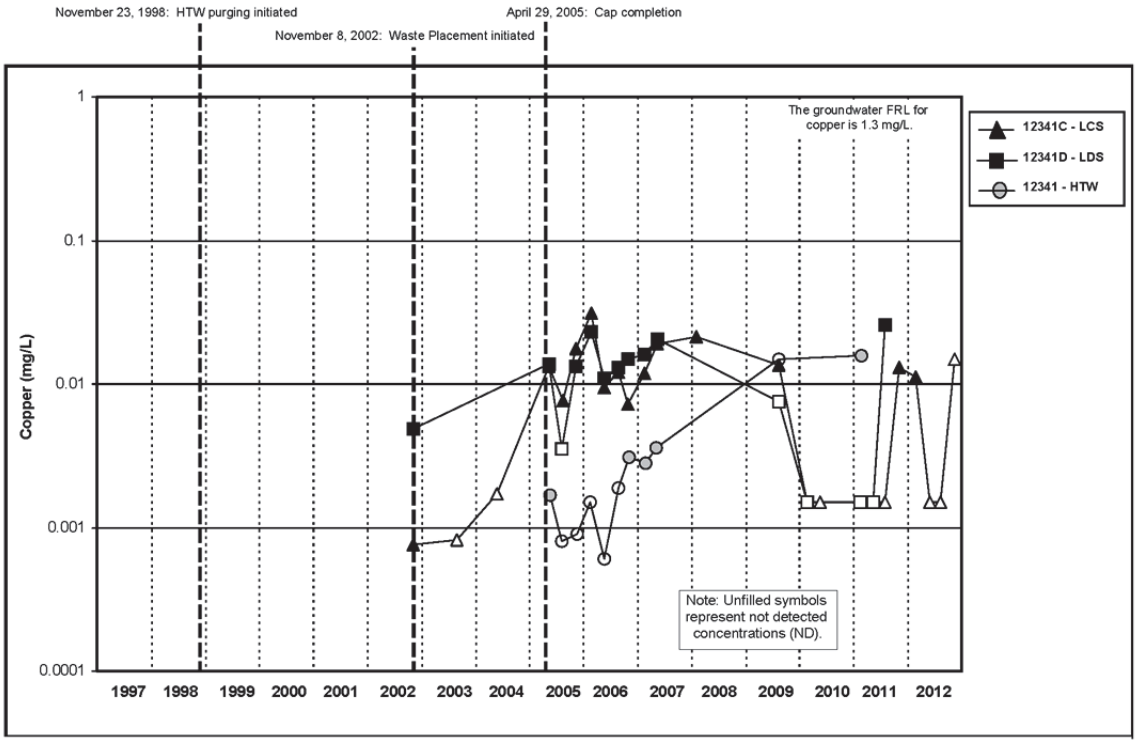


Figure A.5.4–20A. Cell 4 Copper Concentration vs. Time Plot for LCS, LDS, and HTW

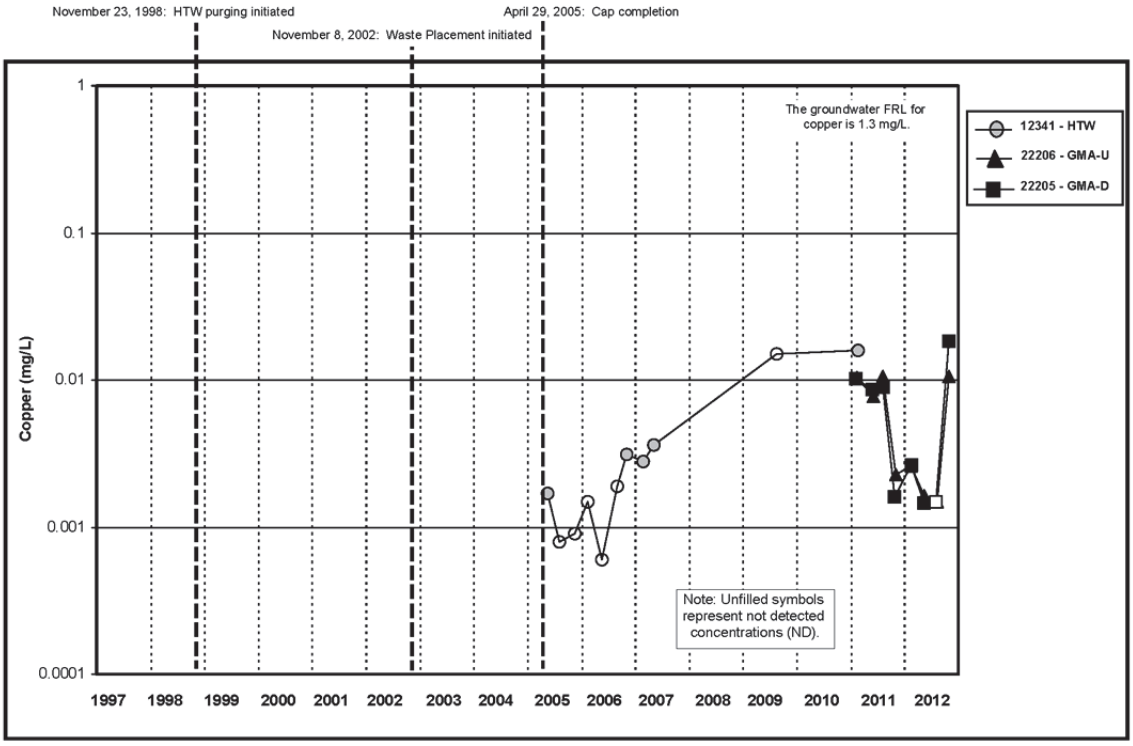


Figure A.5.4–20B. Cell 4 Copper Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

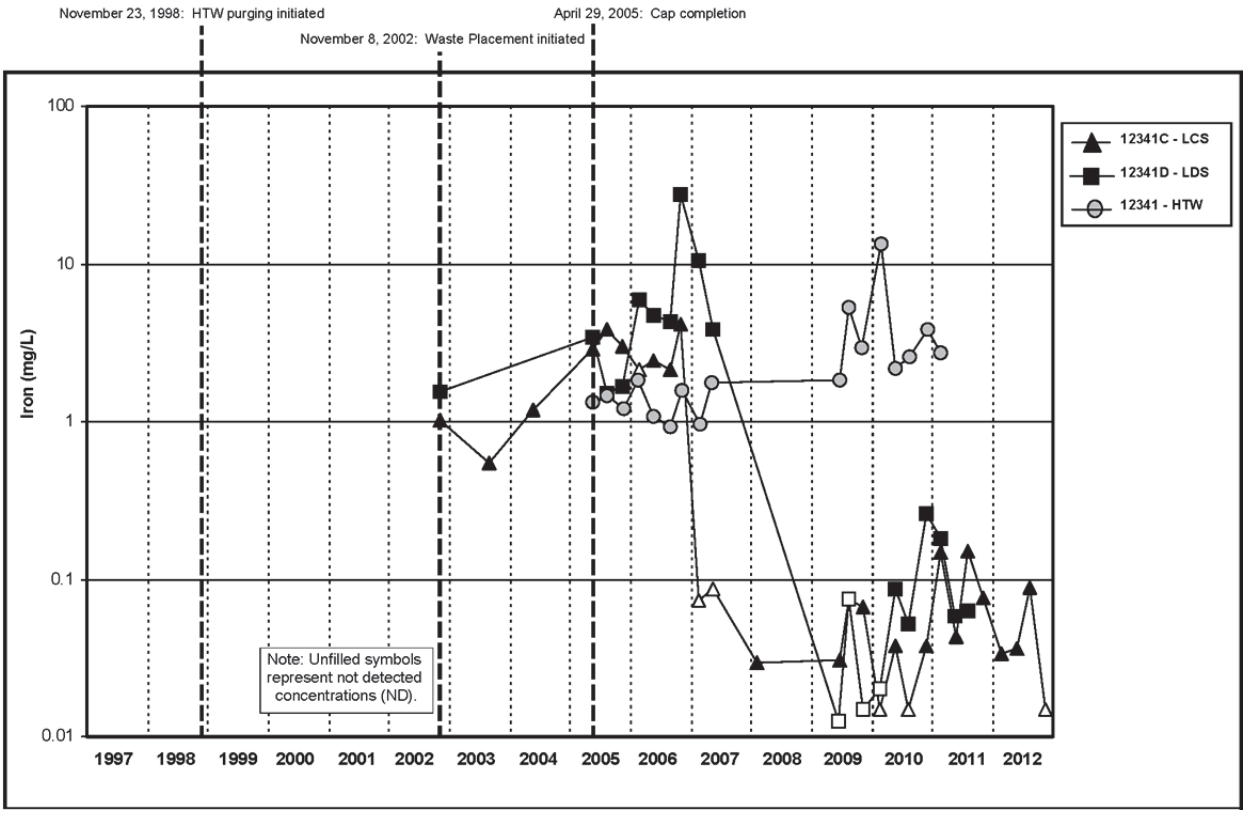


Figure A.5.4–21A. Cell 4 Iron Concentration vs. Time Plot for LCS, LDS, and HTW

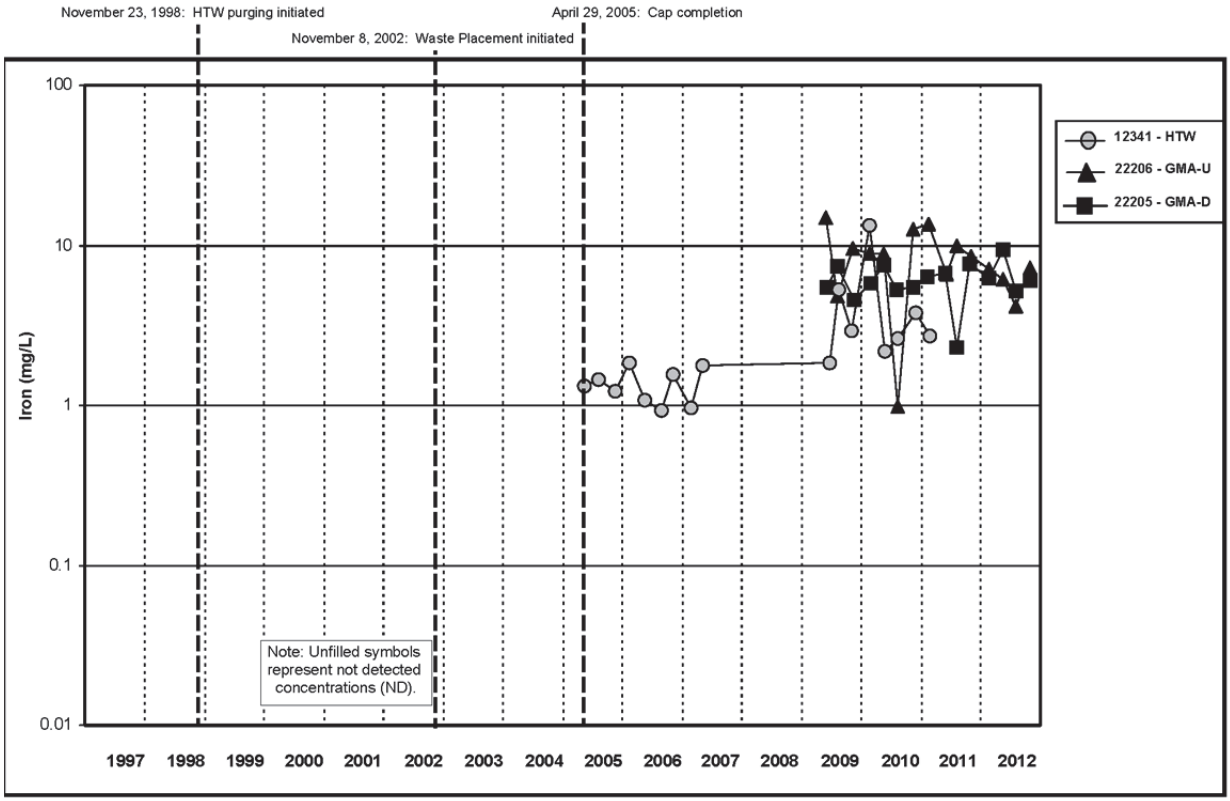


Figure A.5.4–21B. Cell 4 Iron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

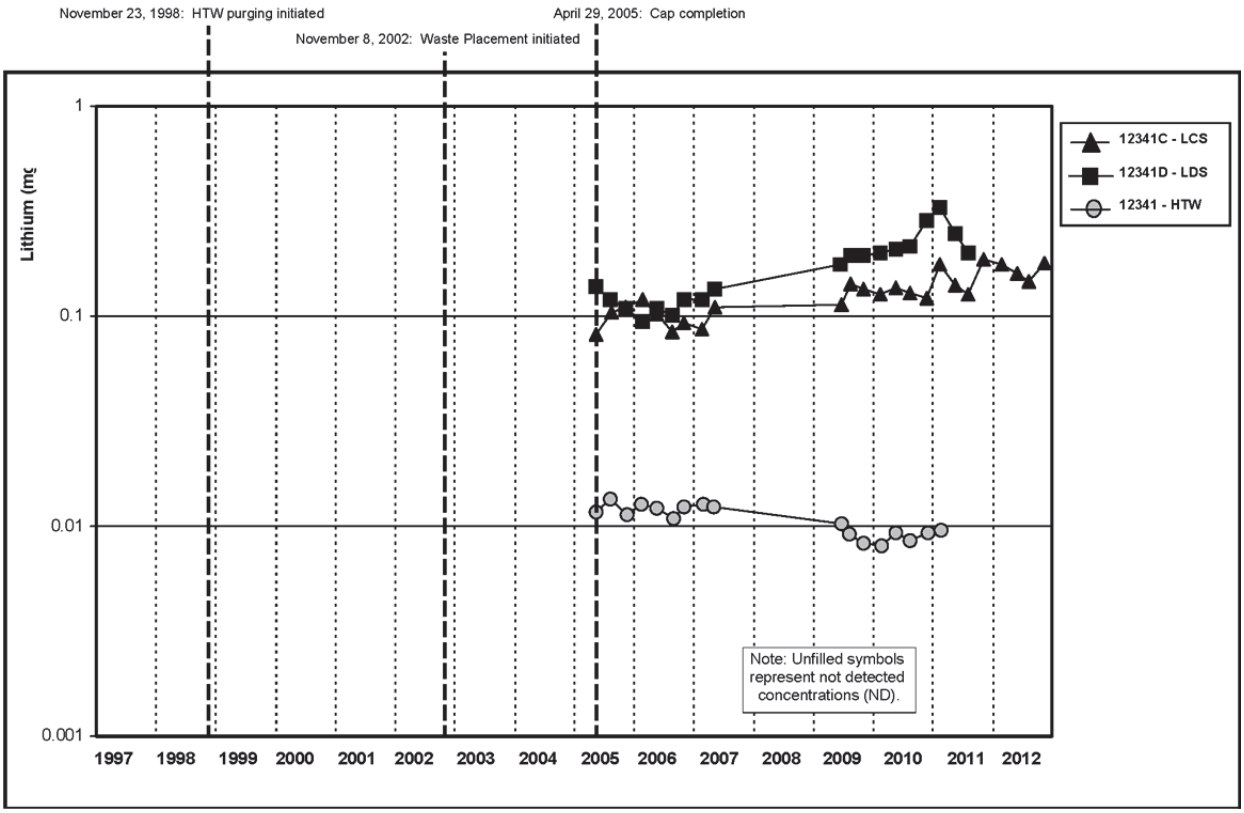


Figure A.5.4–22A. Cell 4 Lithium Concentration vs. Time Plot for LCS, LDS, and HTW

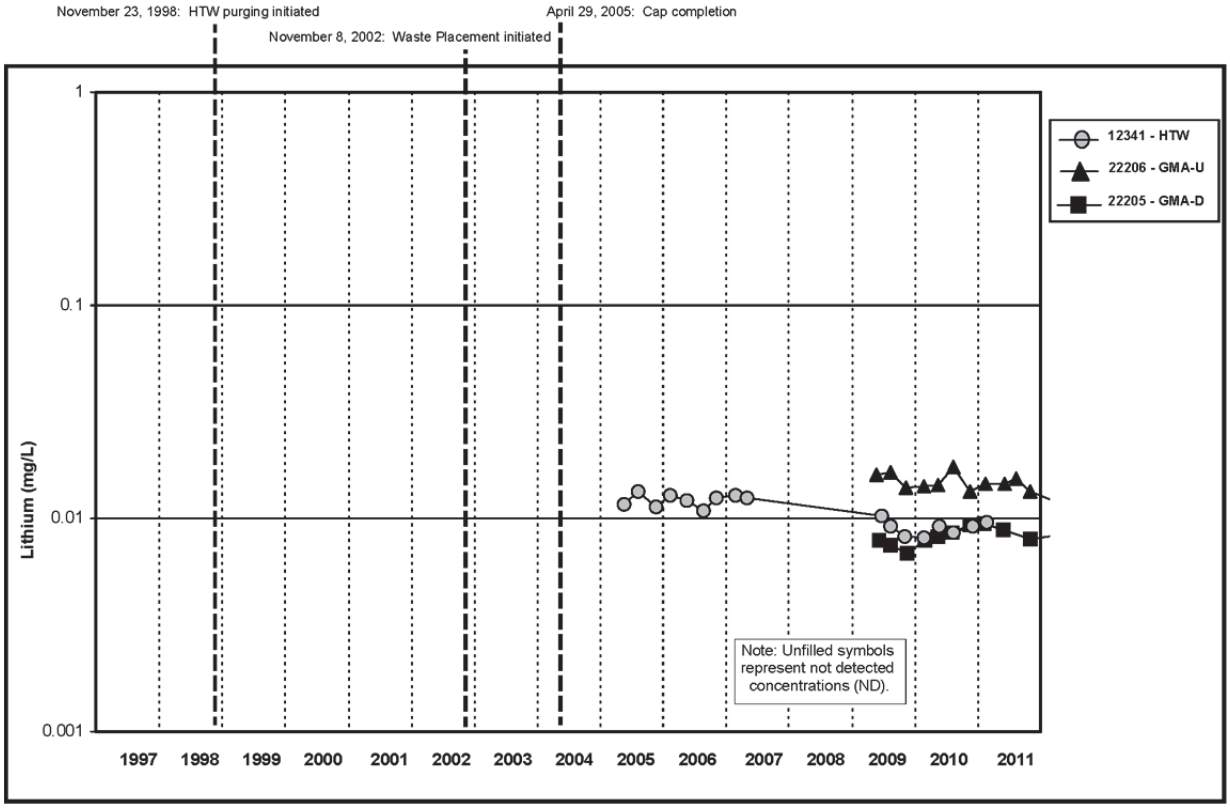


Figure A.5.4–22B. Cell 4 Lithium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

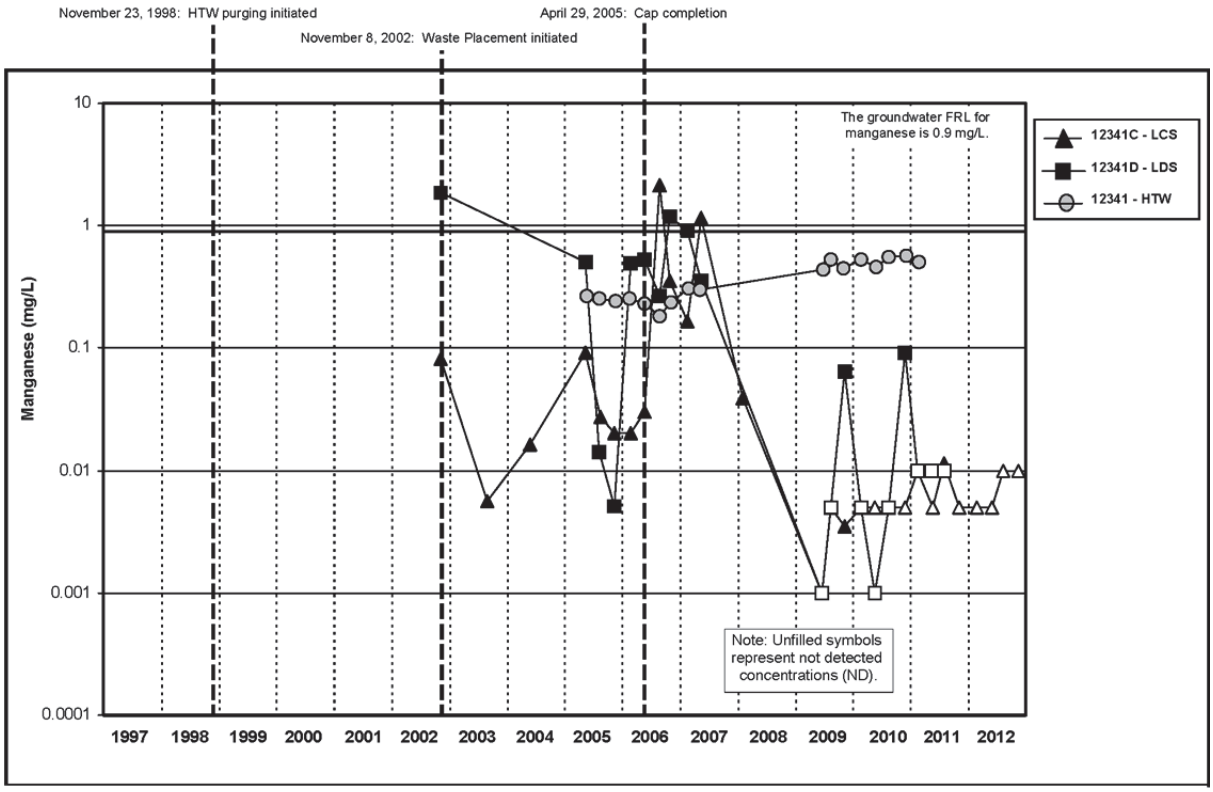


Figure A.5.4–23A. Cell 4 Manganese Concentration vs. Time Plot for LCS, LDS, and HTW

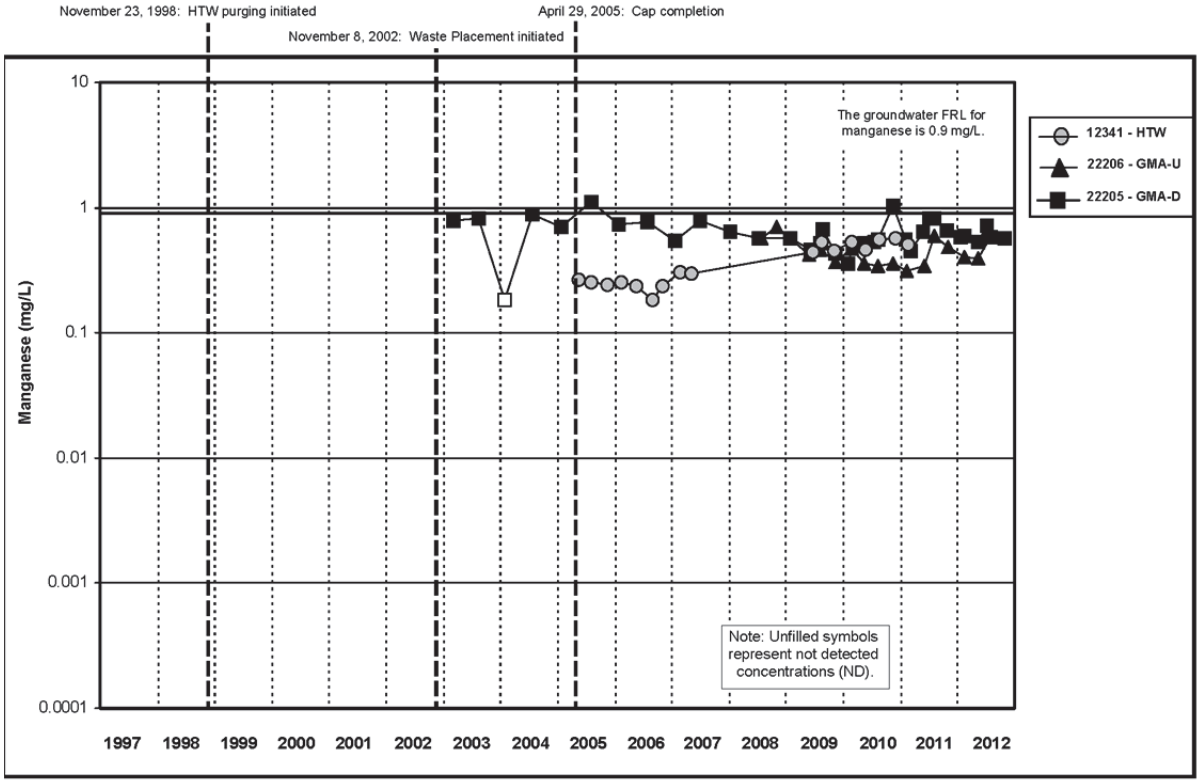


Figure A.5.4–23B. Cell 4 Manganese Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

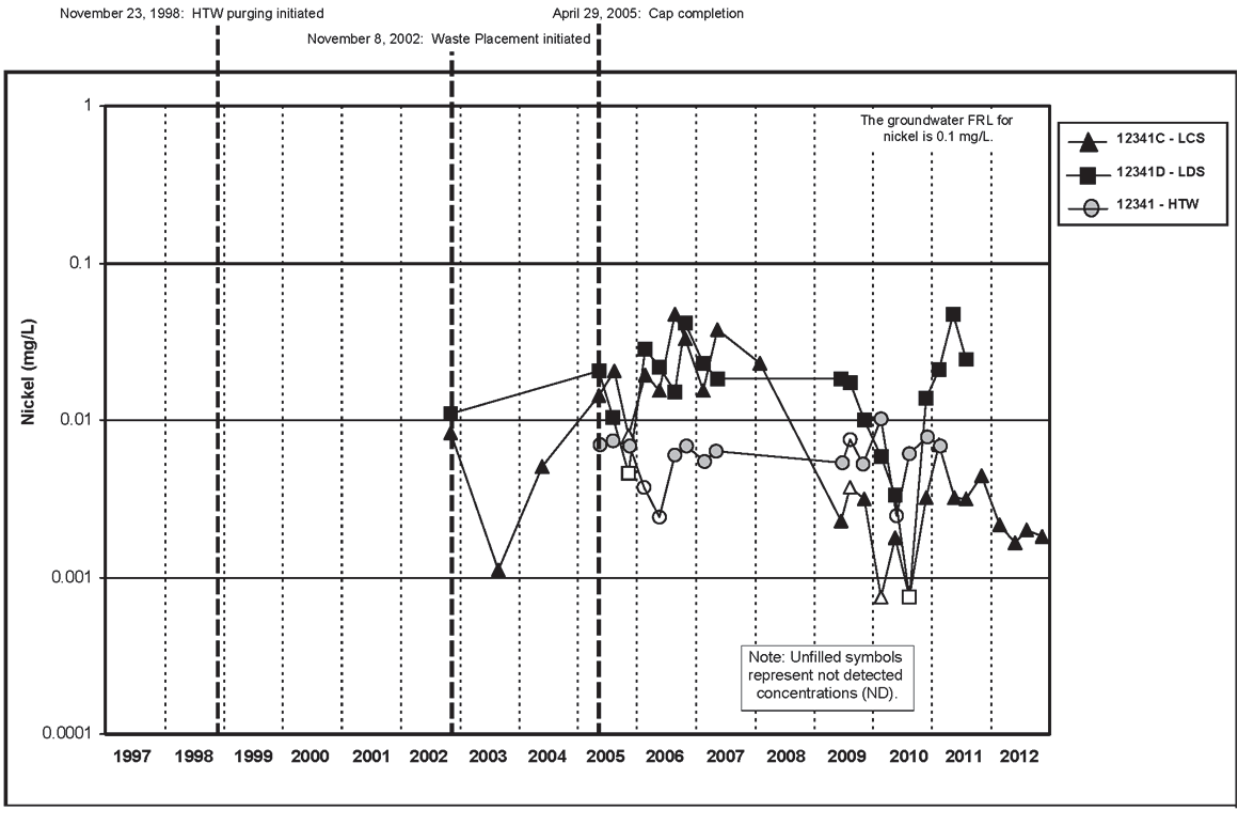


Figure A.5.4–24A. Cell 4 Nickel Concentration vs. Time Plot for LCS, LDS, and HTW

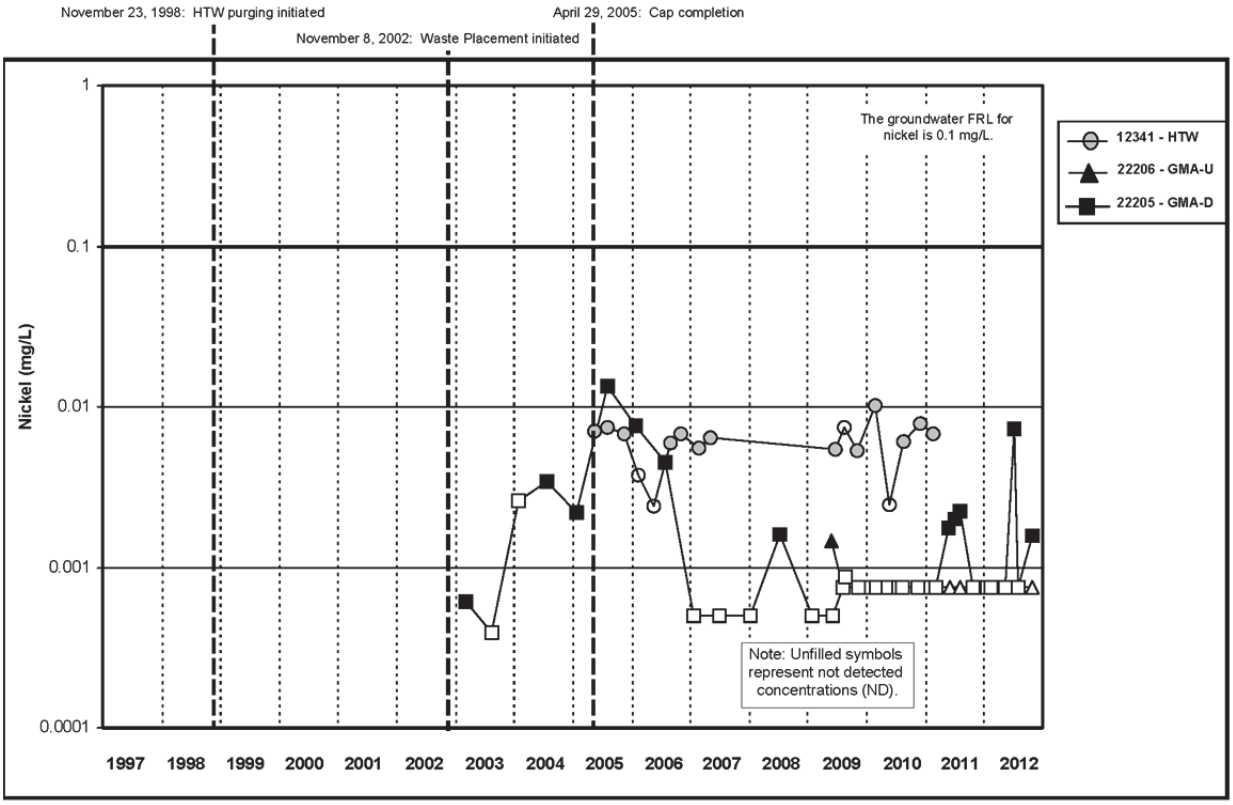


Figure A.5.4–24B. Cell 4 Nickel Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

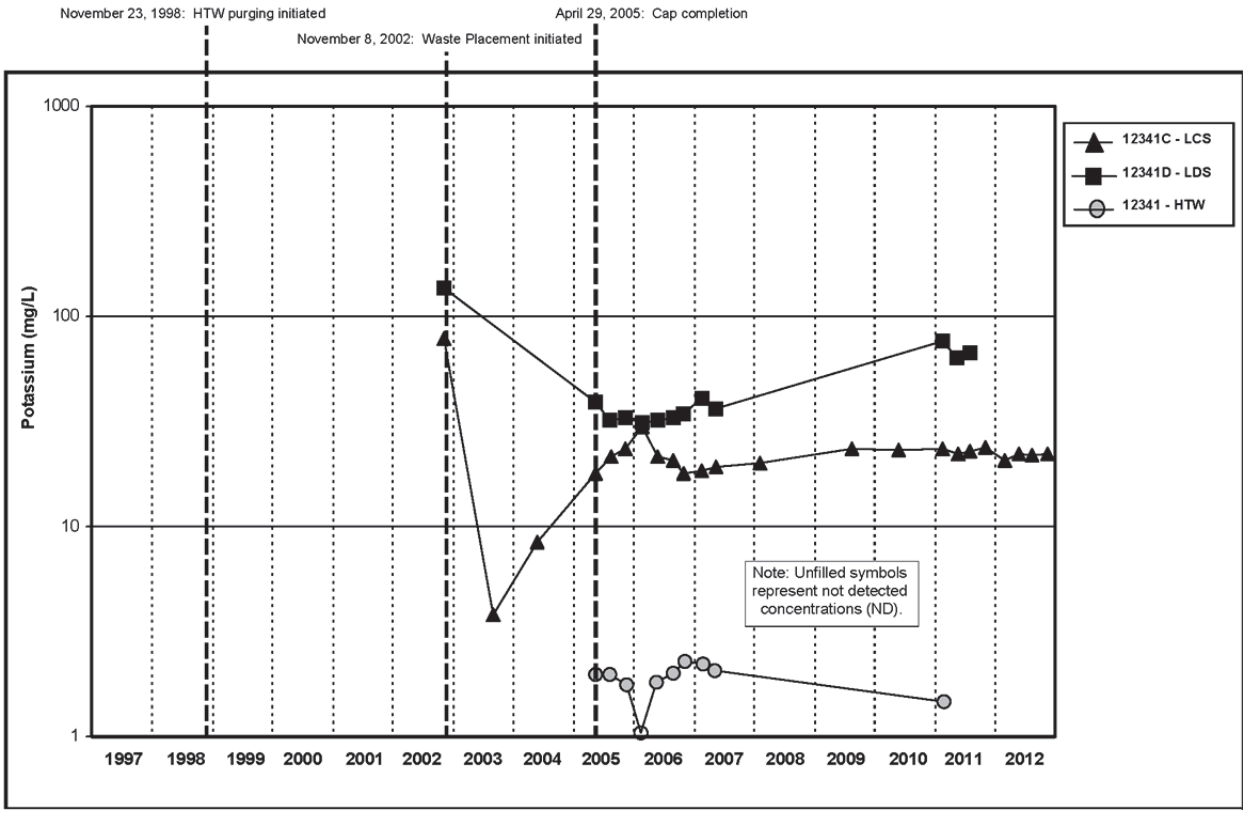


Figure A.5.4–25A. Cell 4 Potassium Concentration vs. Time Plot for LCS, LDS, and HTW

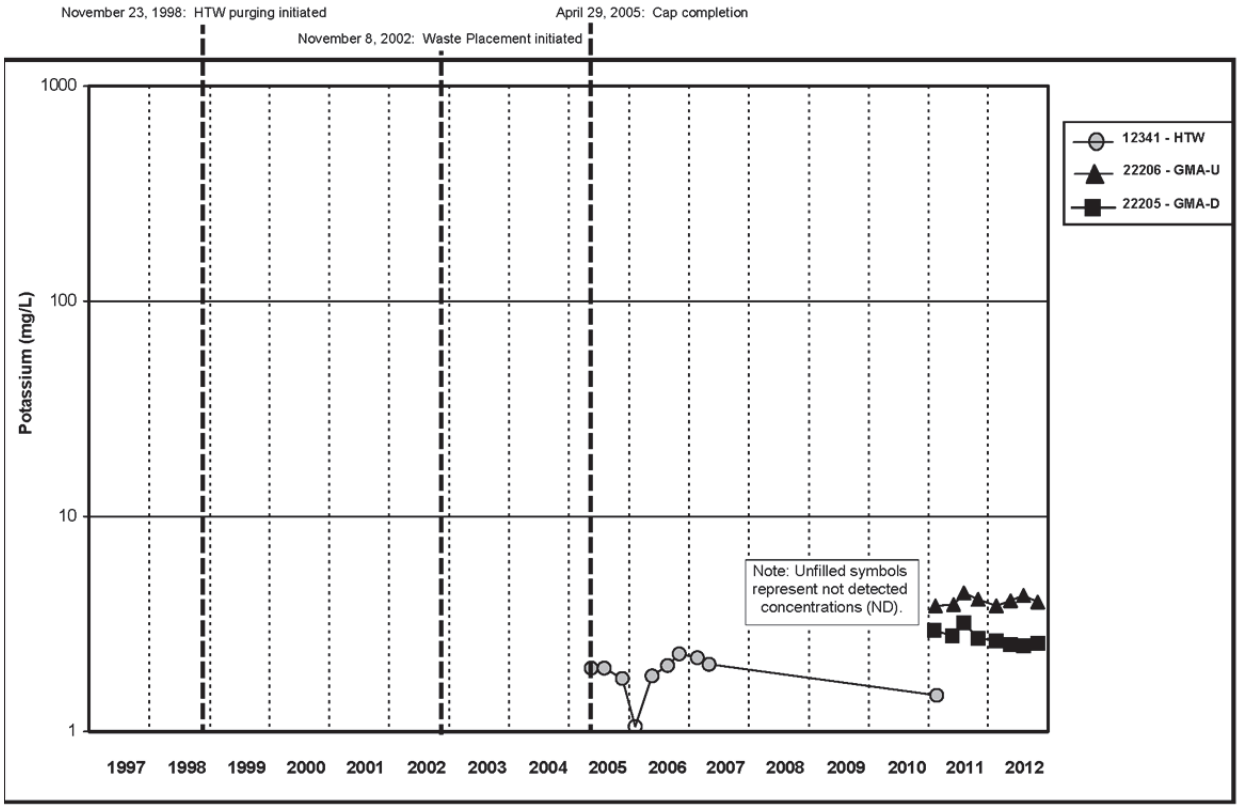


Figure A.5.4–25B. Cell 4 Potassium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

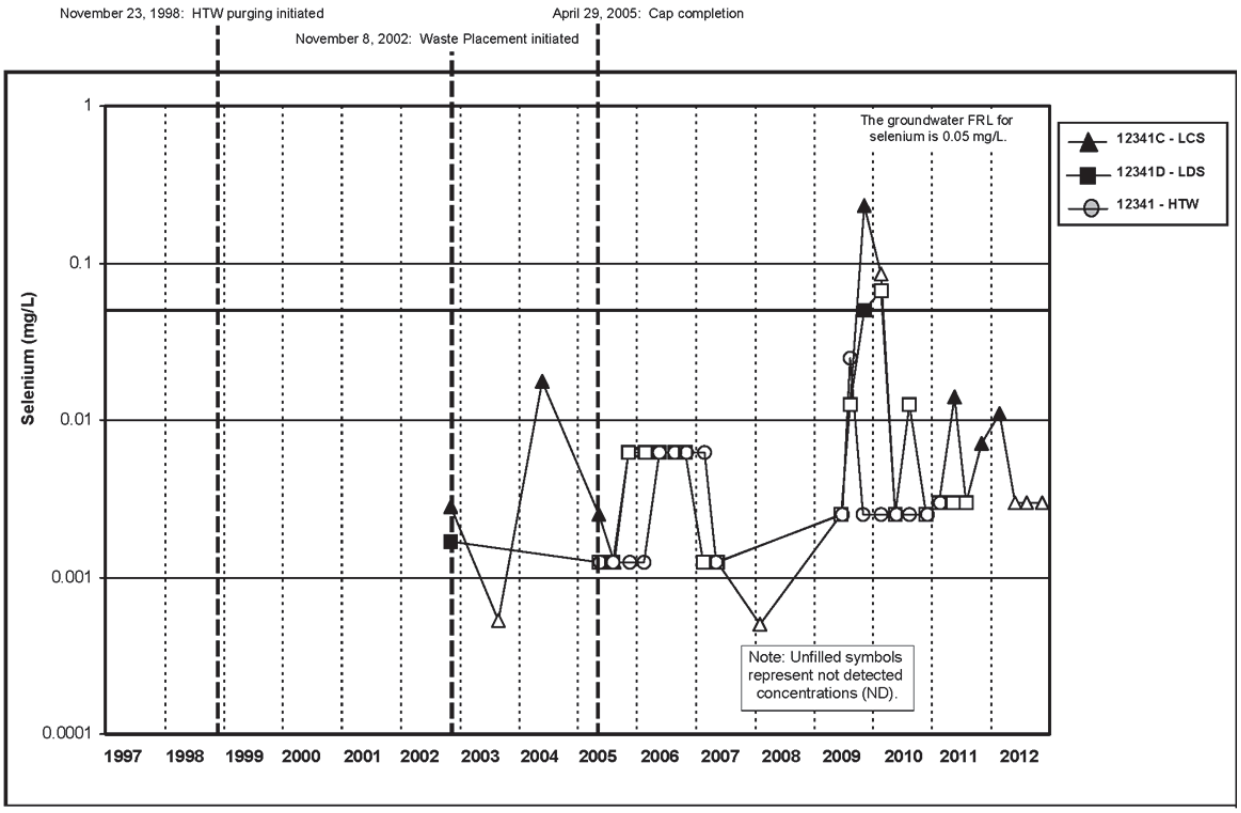


Figure A.5.4–26A. Cell 4 Selenium Concentration vs. Time Plot for LCS, LDS, and HTW

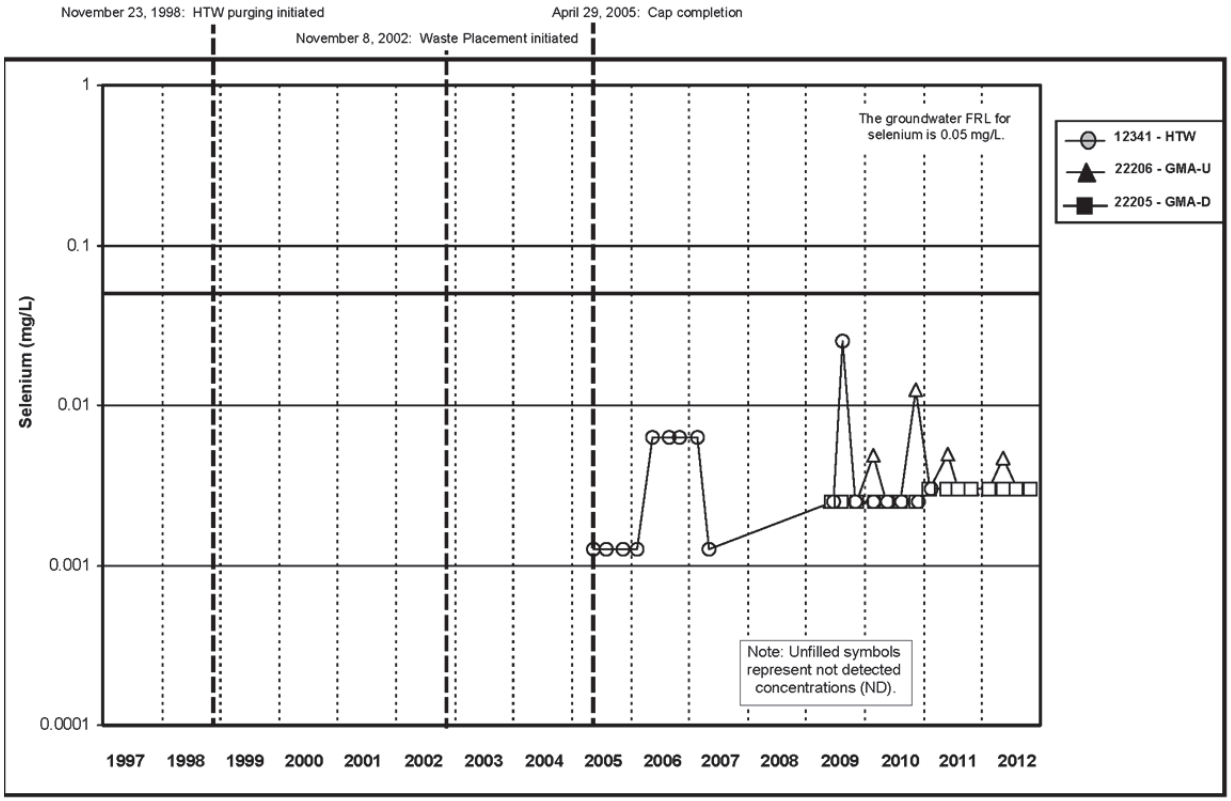


Figure A.5.4–26B. Cell 4 Selenium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

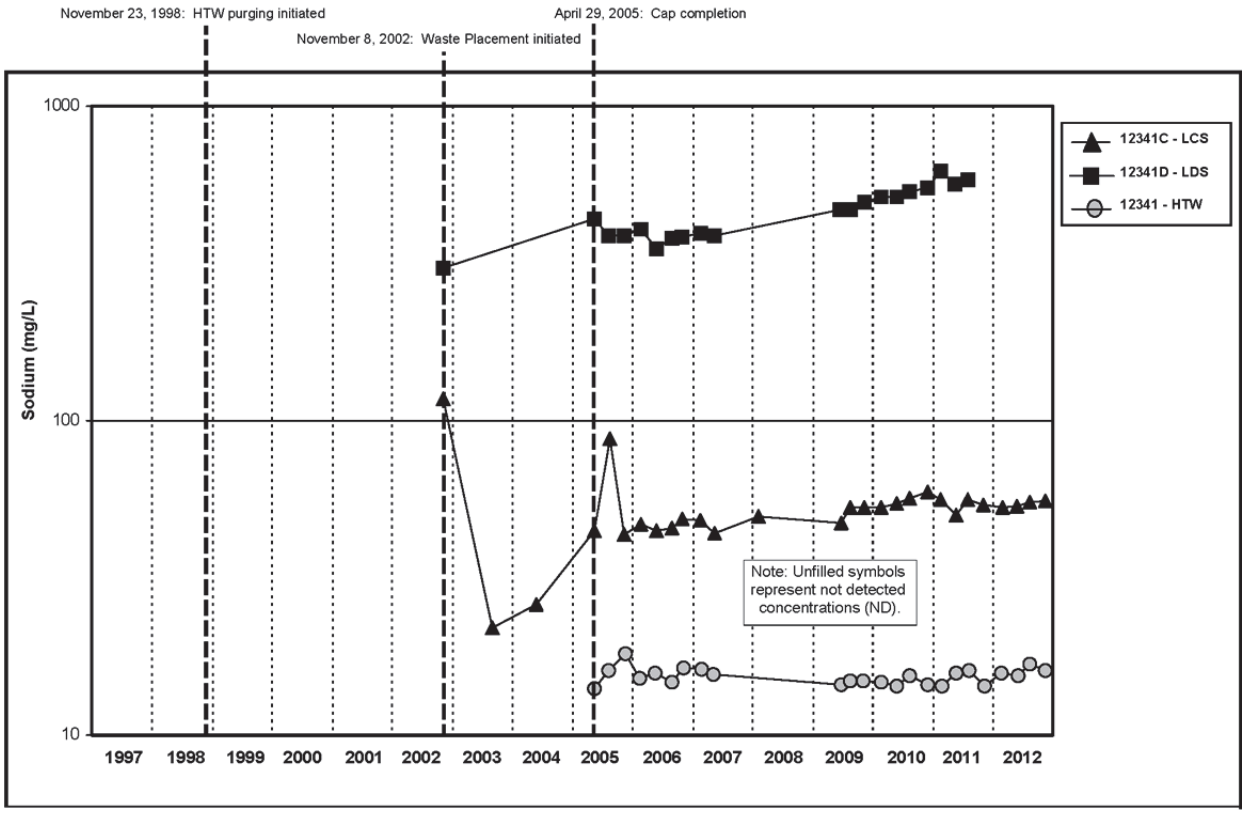


Figure A.5.4–27A. Cell 4 Sodium Concentration vs. Time Plot for LCS, LDS, and HTW

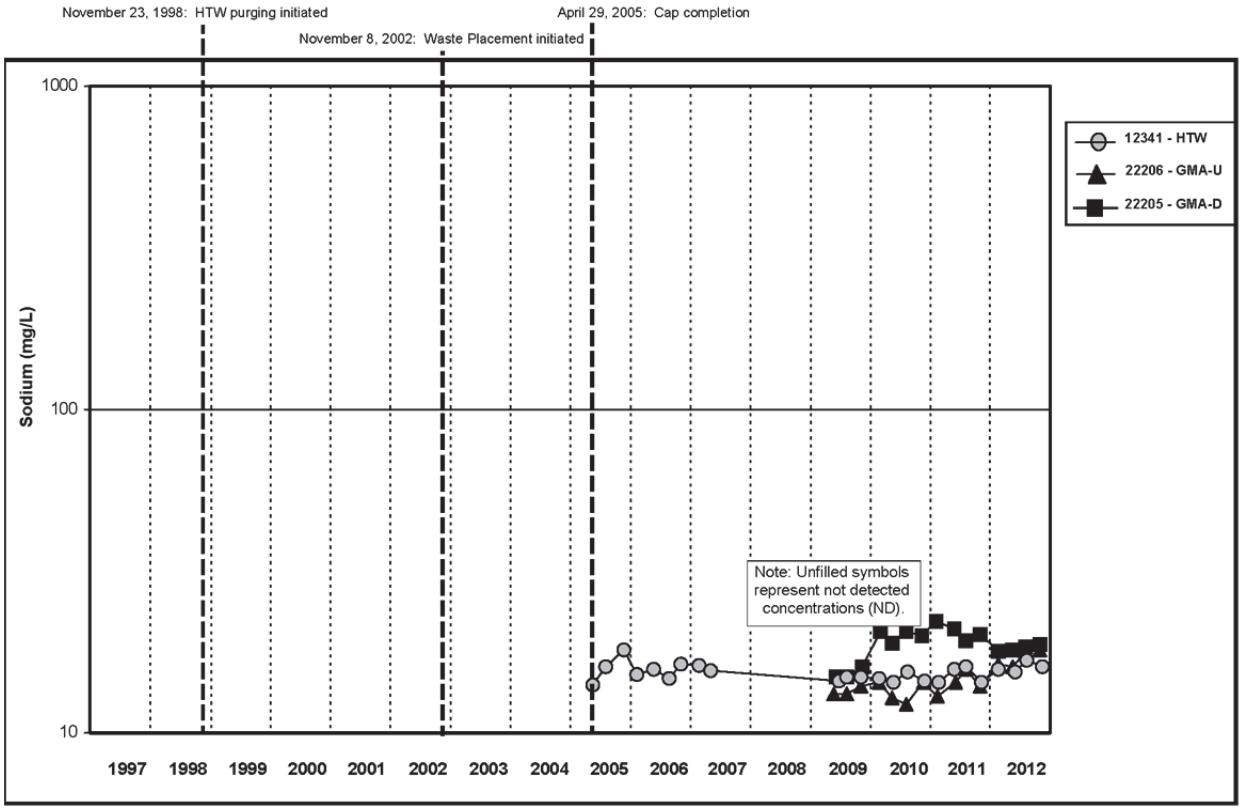


Figure A.5.4–27B. Cell 4 Sodium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

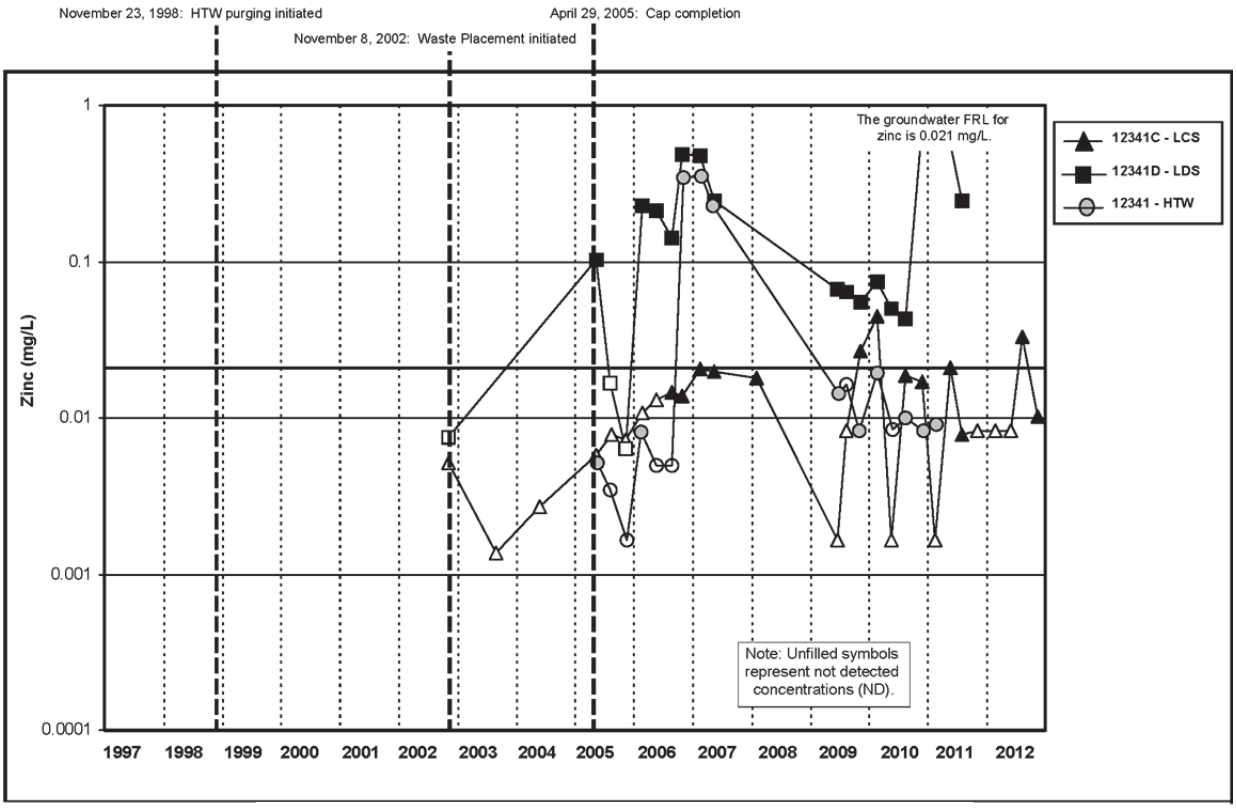


Figure A.5.4–28A. Cell 4 Zinc Concentration vs. Time Plot for LCS, LDS, and HTW

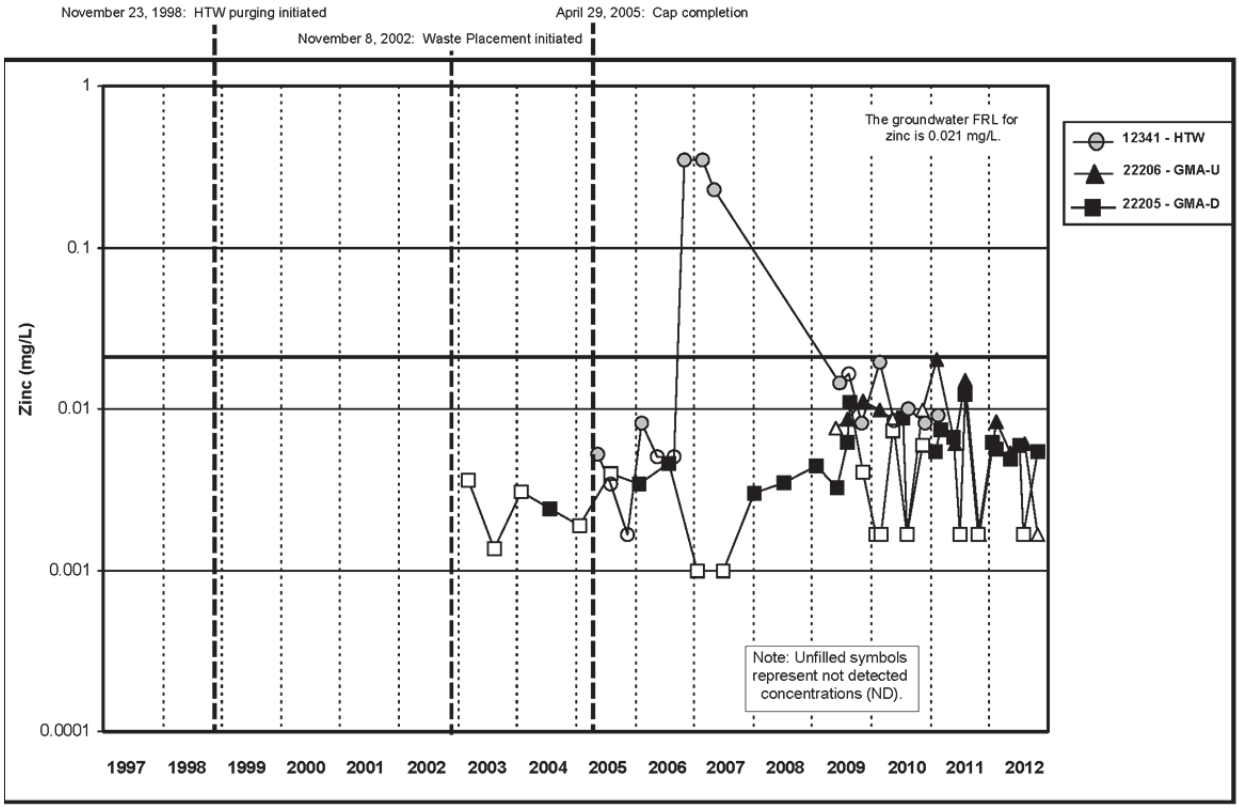


Figure A.5.4–28B. Cell 4 Zinc Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

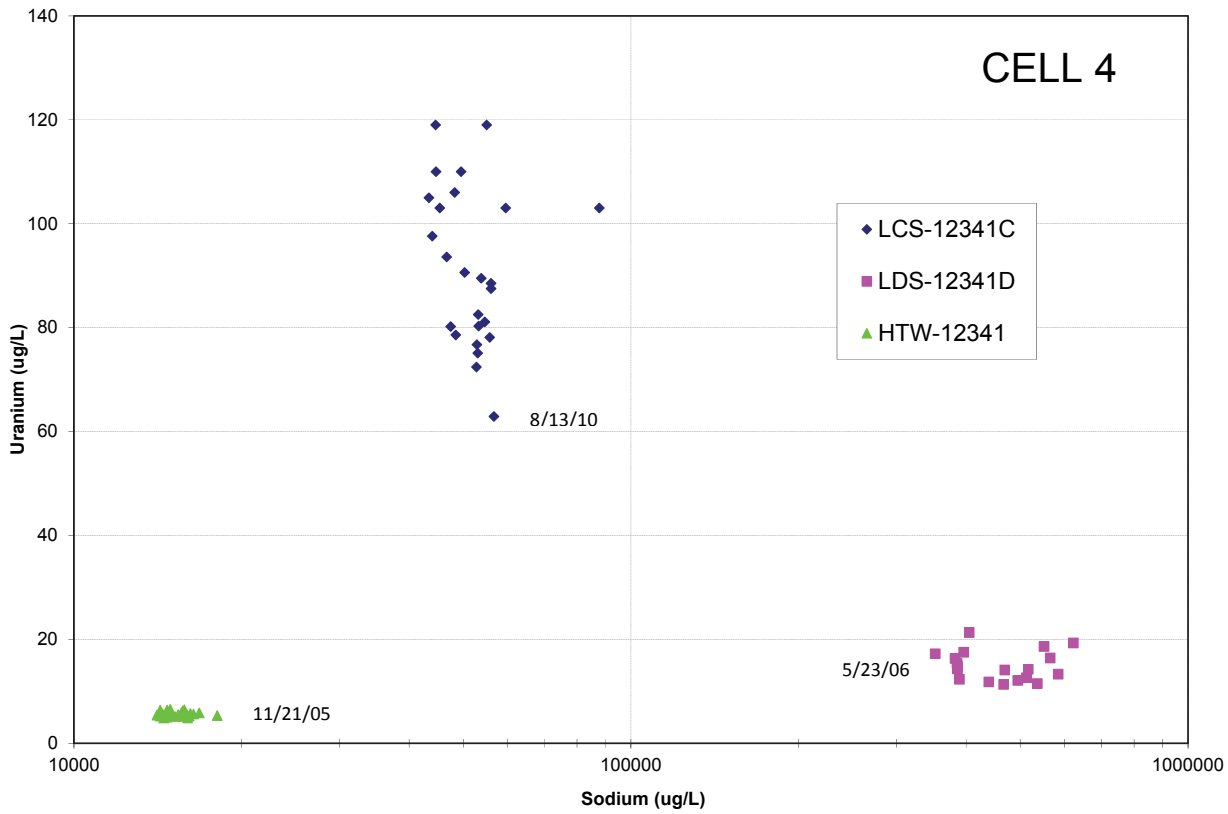


Figure A.5.4–29. Cell 4 Bivariate Plot for Uranium and Sodium

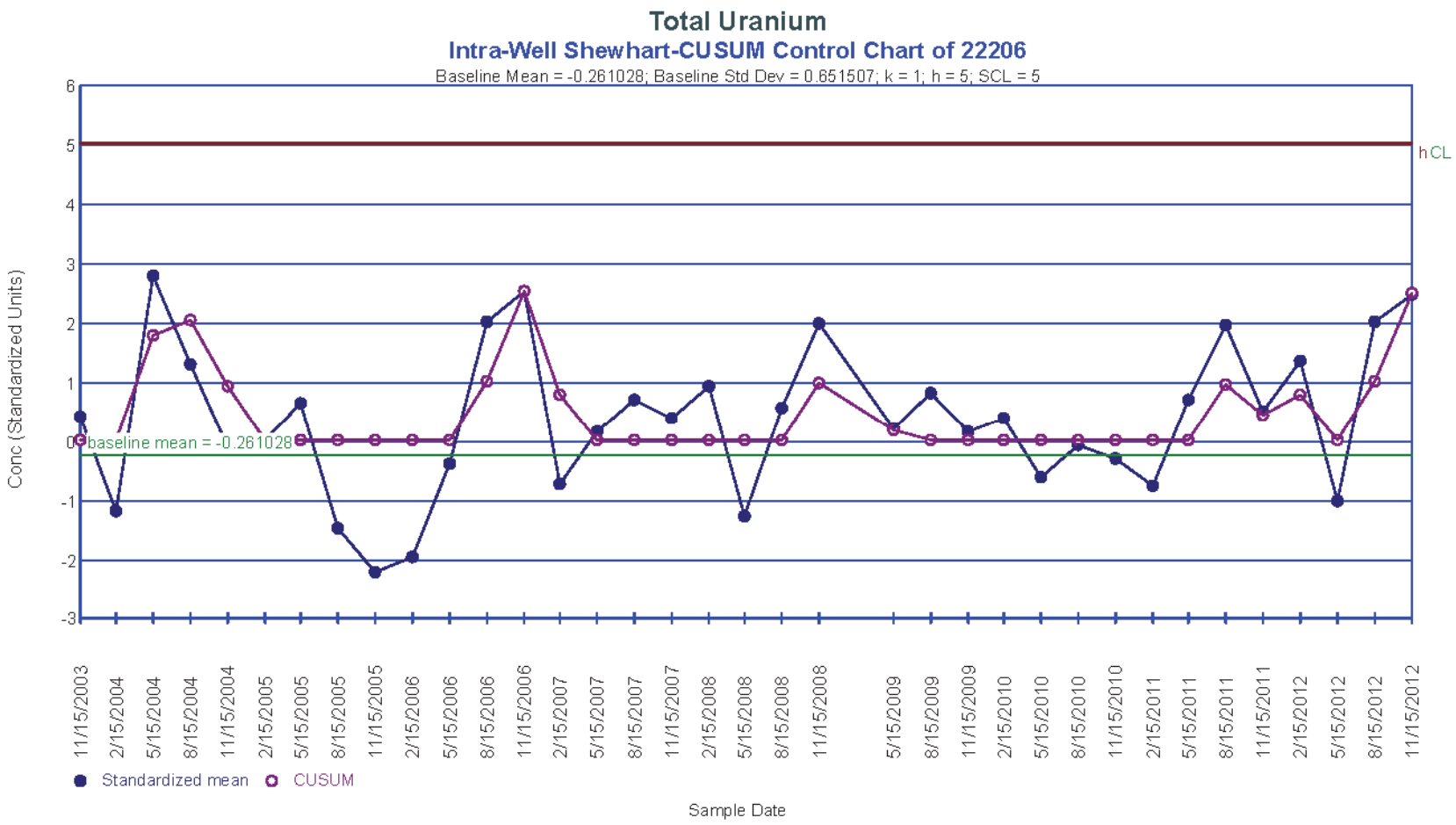


Figure A.5.4–30. Intra-Well Shewhart-CUSUM Control Chart (Total Uranium 22206)

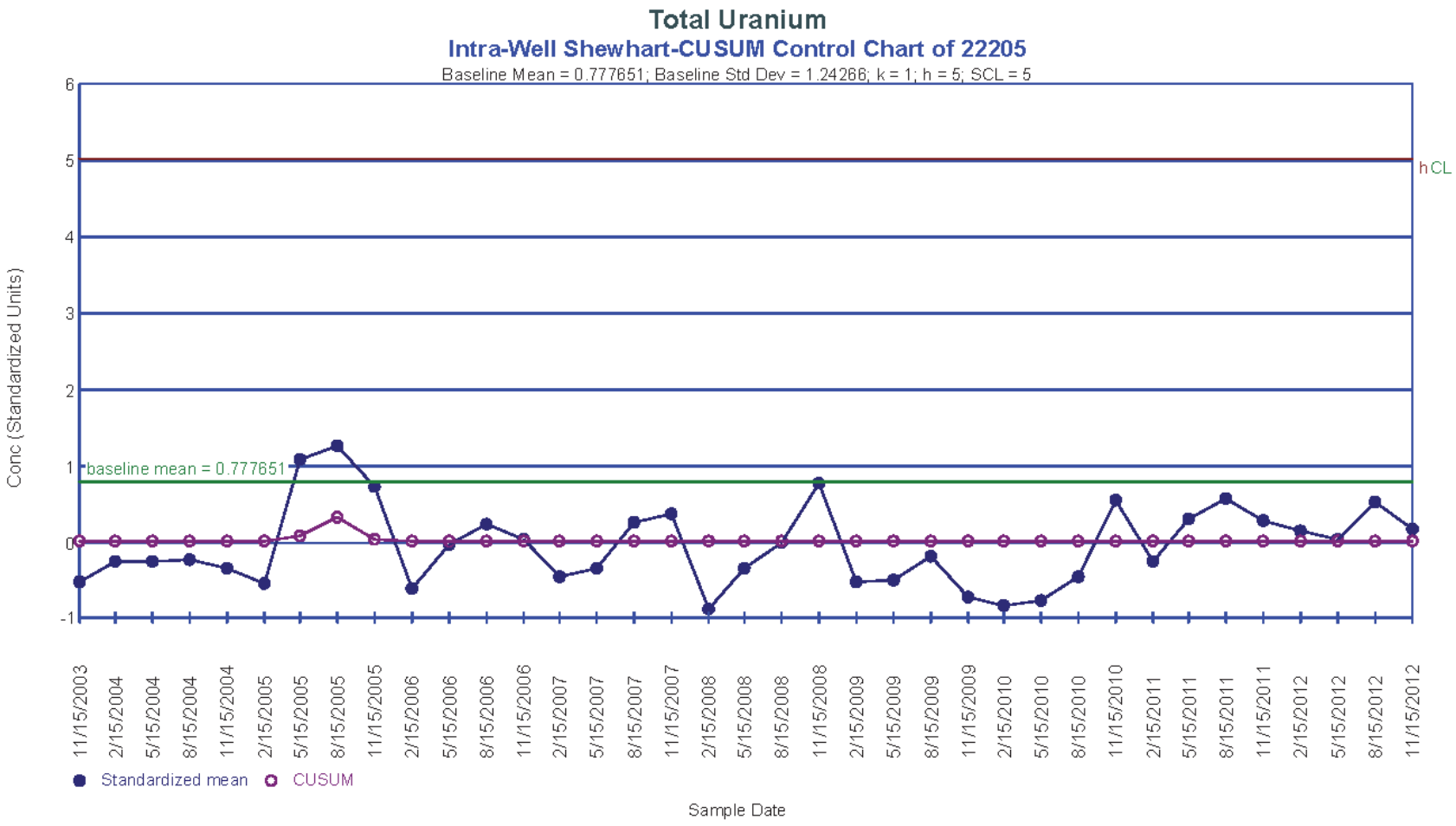


Figure A.5.4–31. Intra-Well Shewhart-CUSUM Control Chart (Total Uranium 22205)

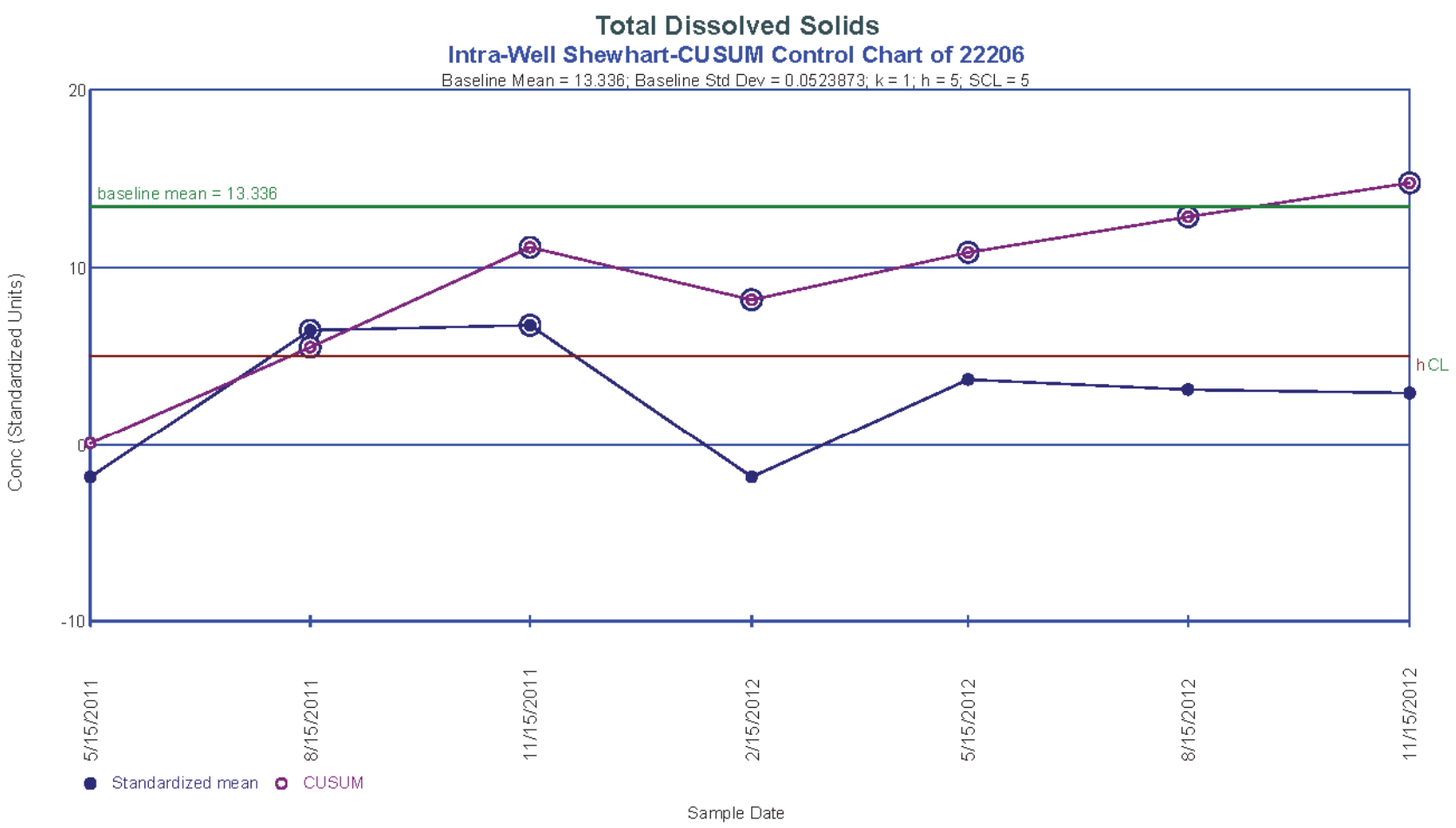


Figure A.5.4–32. Intra-Well Shewhart-CUSUM Control Chart (Total Dissolved Solids 22206)

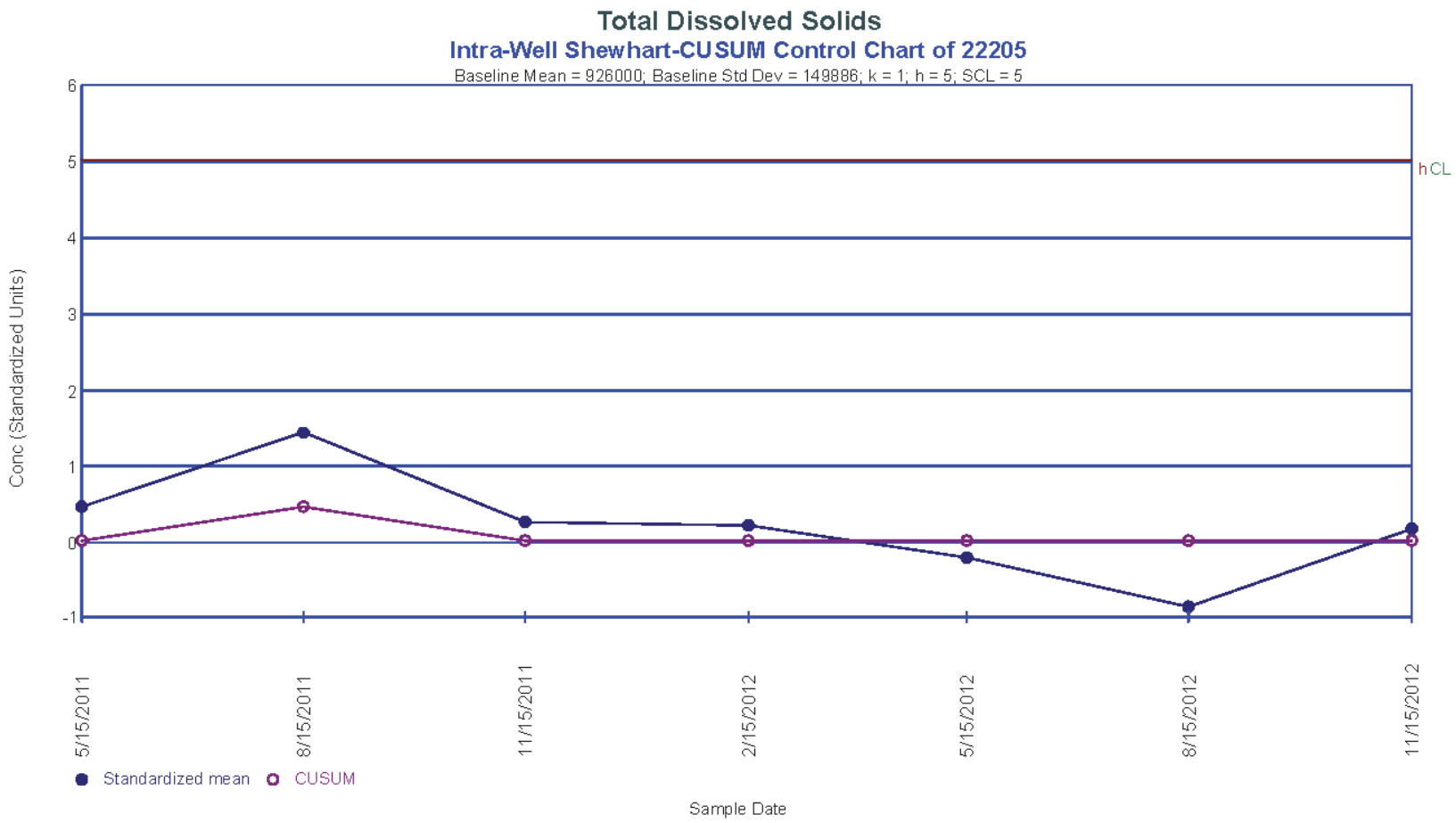


Figure A.5.4–33. Intra-Well Shewhart-CUSUM Control Chart (Total Dissolved Solids 22205)

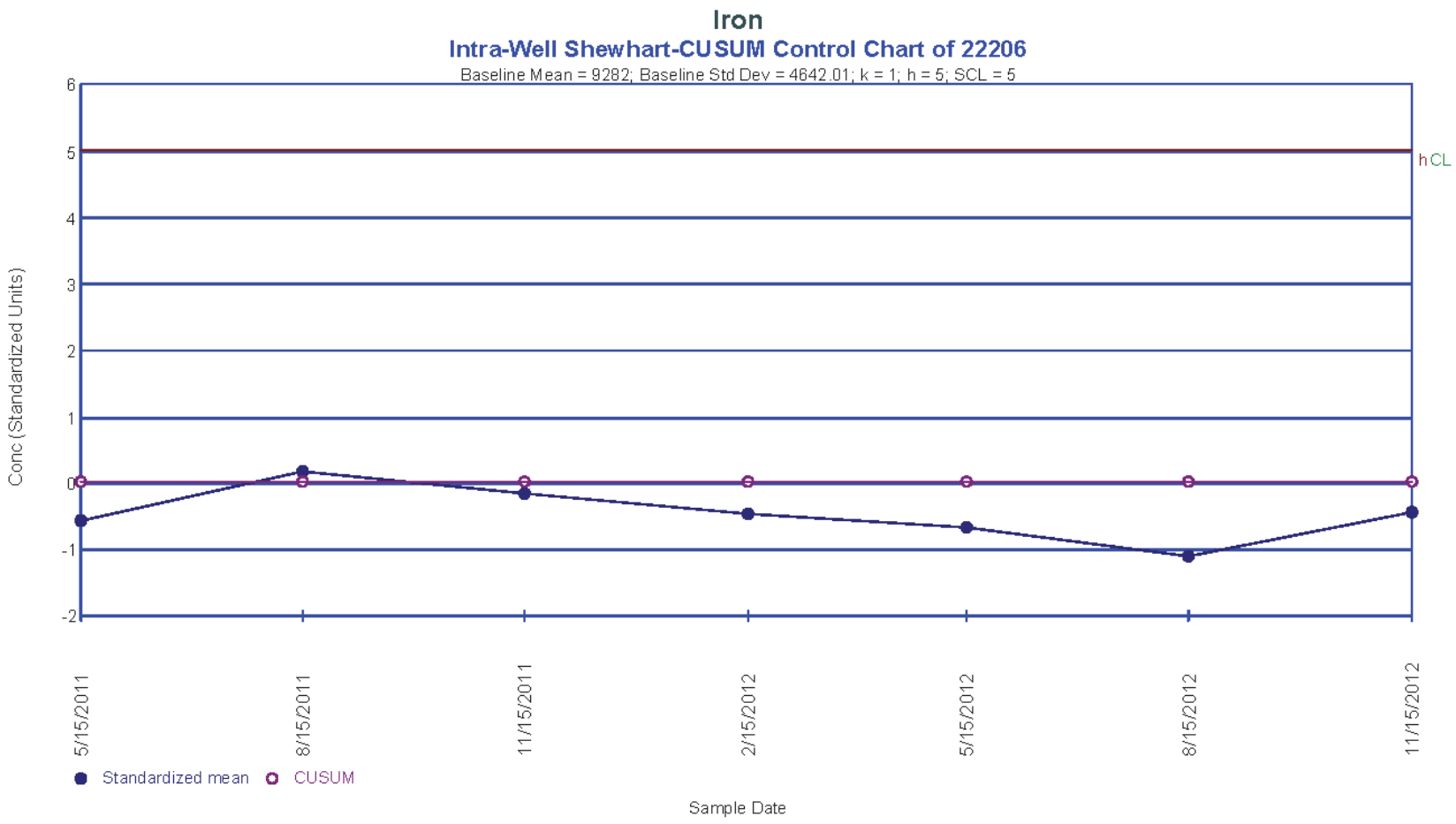


Figure A.5.4–34. Intra-Well Shewhart-CUSUM Control Chart (Iron 22206)

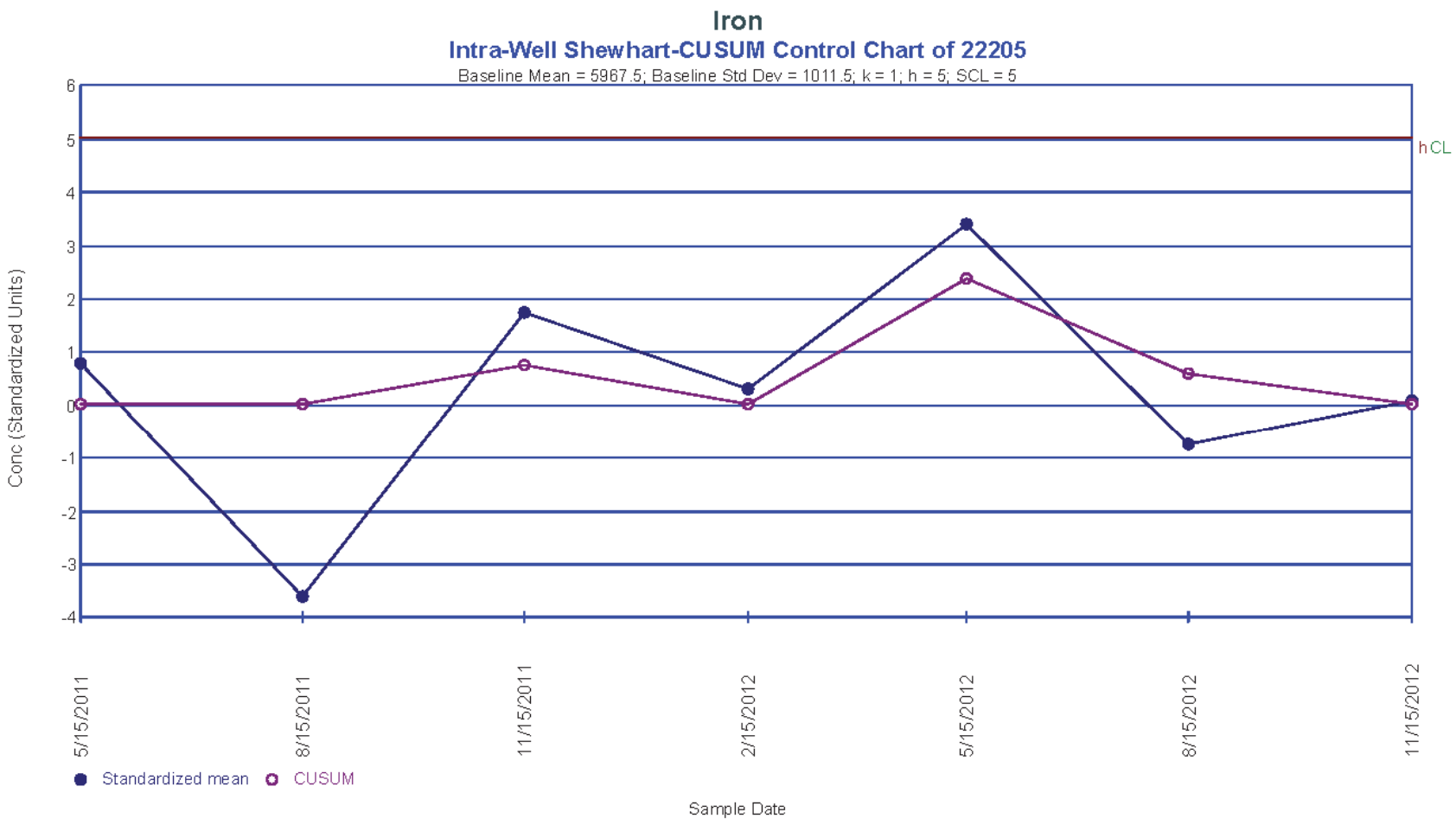


Figure A.5.4–35. Intra-Well Shewhart-CUSUM Control Chart (Iron 22205)

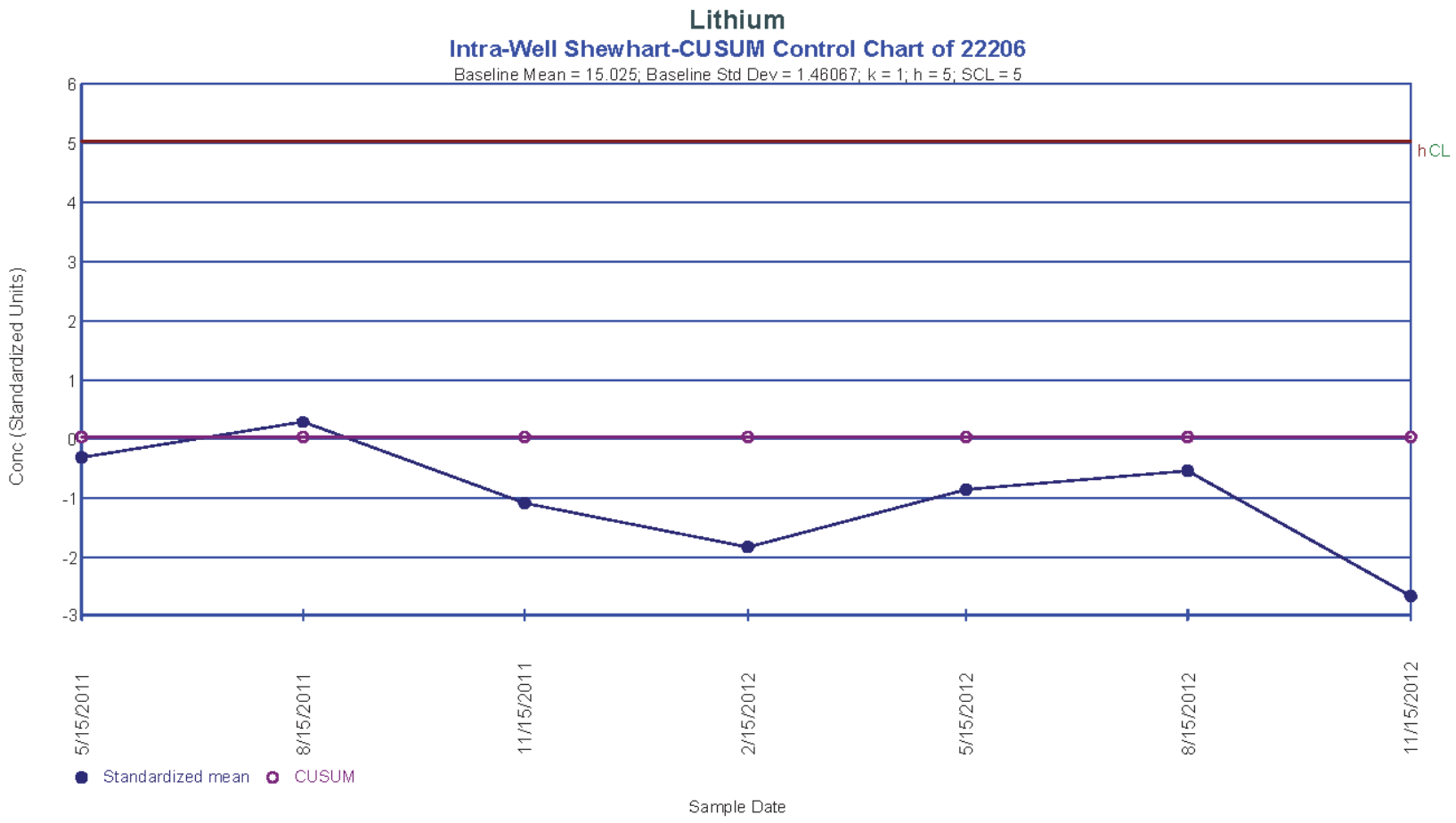


Figure A.5.4–36. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22206)

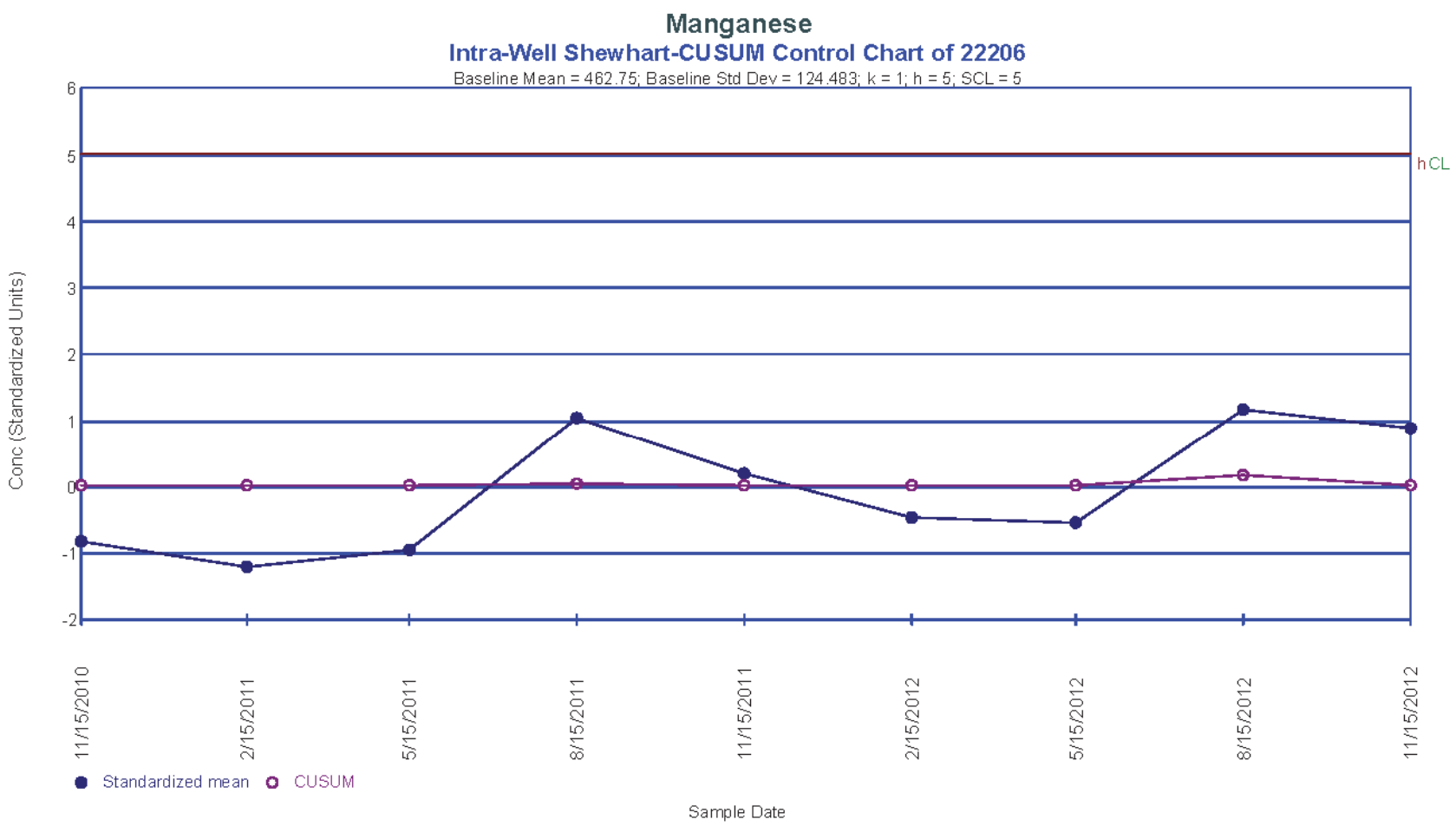


Figure A.5.4–37. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22206)

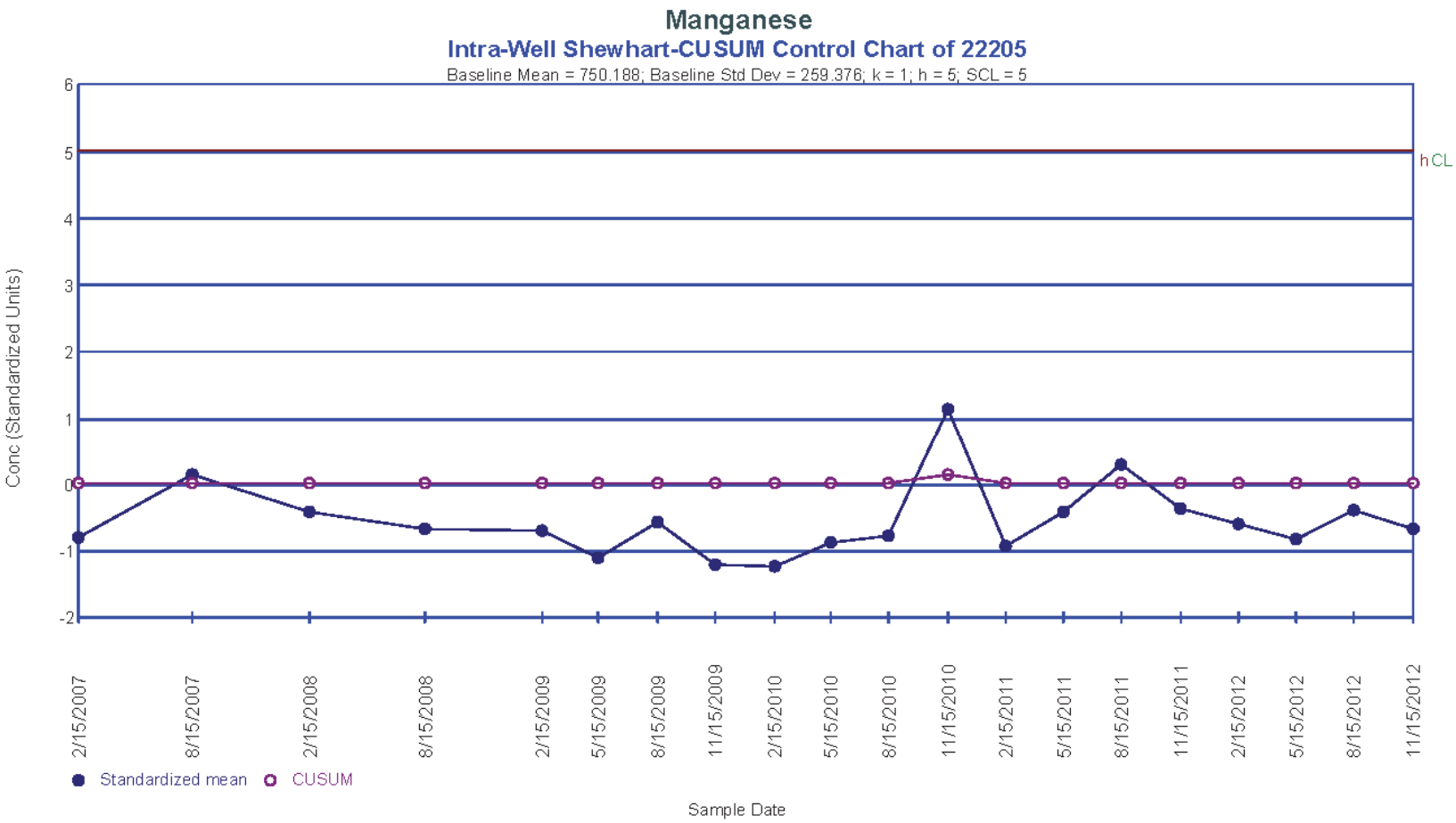


Figure A.5.4–38. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22205)

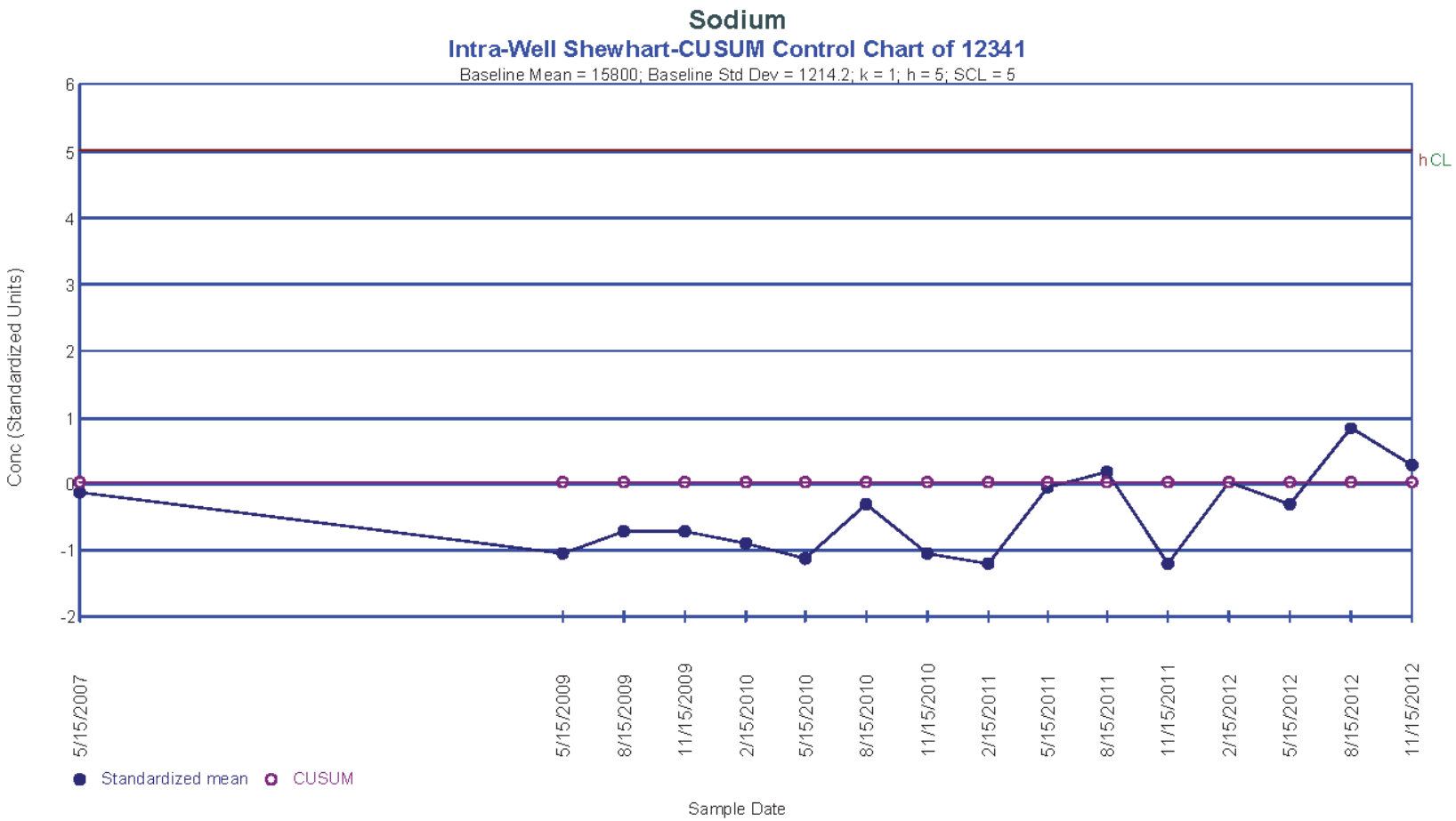


Figure A.5.4–39. Intra-Well Shewhart-CUSUM Control Chart (Sodium 12341)

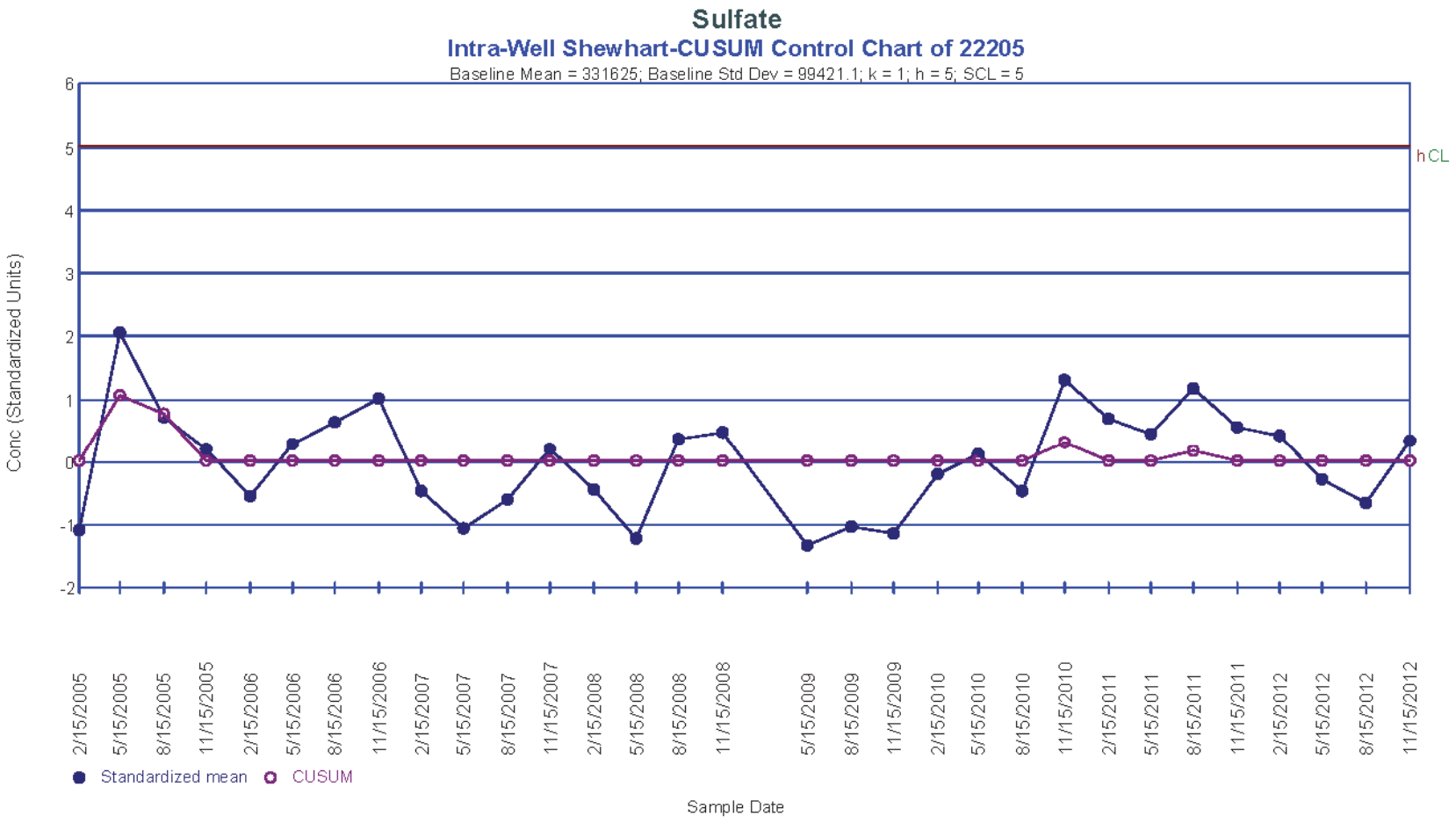


Figure A.5.4–40. Intra-Well Shewhart-CUSUM Control Chart (Sulfate 22205)

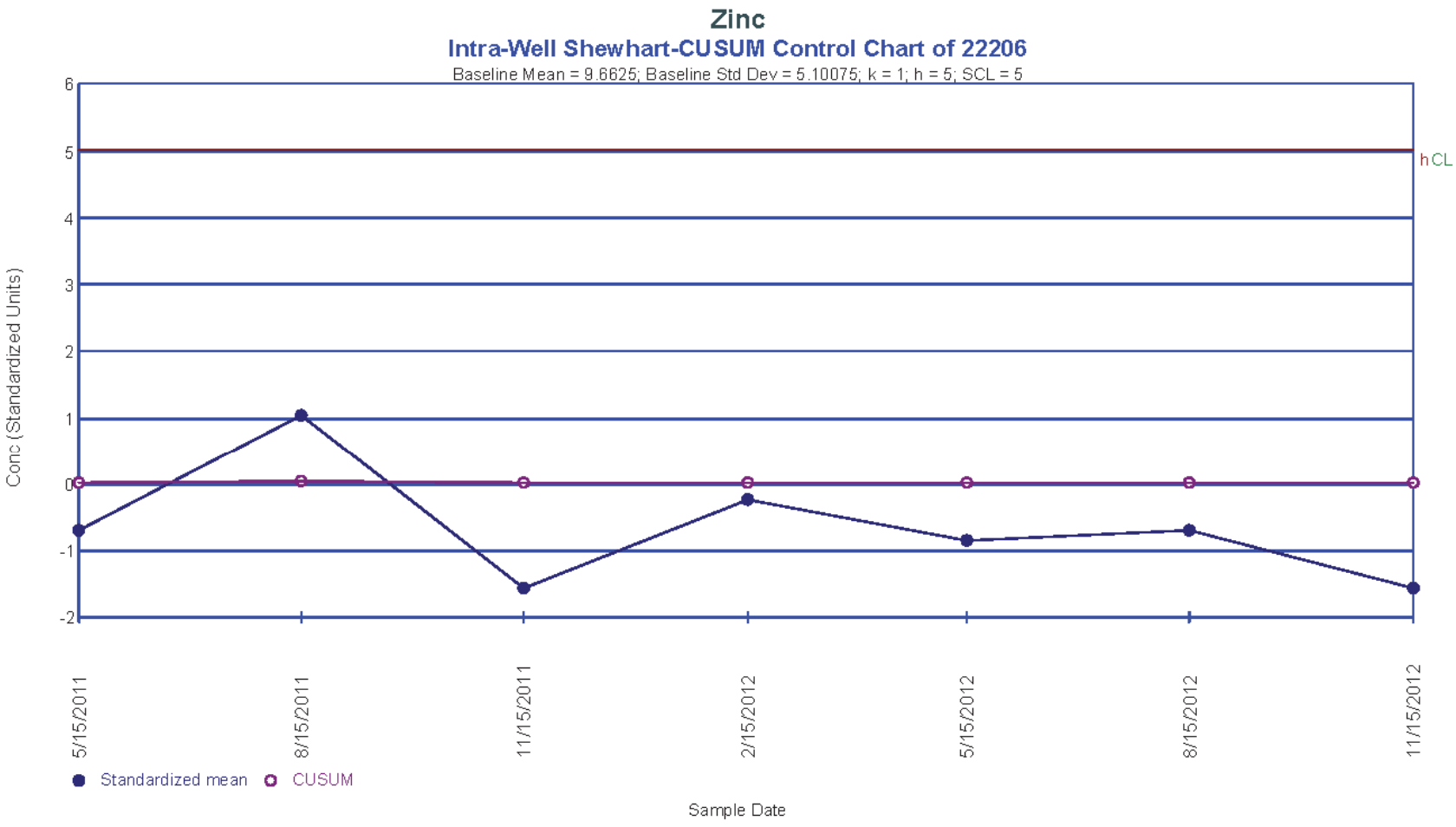


Figure A.5.4–41. Intra-Well Shewhart CUCSM Control Chart (Zinc 22206)

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Sub-attachment A.5.5

Cell 5

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The following information is provided in this sub-attachment:

- Quarterly monitoring summary statistics (refer to Table A.5.5–1)
- Annual LCS sample summary information for detected parameters (refer to Table A.5.5–2)
- LCS monthly accumulation volumes (refer to Figure A.5.5–1)
- LDS monthly accumulation volumes (refer to Figure A.5.5–2)
- OSDF horizontal till well 12342 water yield (refer to Figure A.5.5–3)
- GMA water levels and uranium concentration versus time (refer to Figures A.5.5–4 and A.5.5–5)
- Plots of concentration versus time (refer to Figures A.5.5–6A to A.5.5–28B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.5–29)
- Control charts (refer to Figures A.5.5–30 to A.5.5–36)

A.5.5.1 Quarterly Monitoring Results

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within the cell is sampled in the LCS and LDS. Water quality beneath the cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present the results.

In 2012, 23 parameters were sampled in the LCS, LDS, and GMA wells of each cell. HTWs in all cells were sampled for arsenic, uranium, sodium, and sulfate. The LDS of Cell 5 was dry during the first quarter of 2012. In addition to the above samples, Cell 5 is also sampled quarterly in the LCS, LDS, and GMA wells for vanadium.

As shown in Table A.5.5–1, and summarized below, 11 parameters (chloride, sulfate, TOC, arsenic, boron, iron, lithium, magnesium, manganese, selenium, and sodium) have upward trends in the HTW and/or GMA wells based on the Mann-Kendall test for trend.

Parameters with upward concentration trends in the HTW and GMA Wells of Cell 5

Parameter	HTW[a] 12342	GMA-U[a] 22207	GMA-D[a] 22208
Chloride		Up	
Sulfate	Up	Up	
TOC			Up
Arsenic			Up
Boron		Up	Up
Iron			Up
Lithium		Up	
Magnesium			Up
Manganese			Up
Selenium			Up
Sodium	Up		

[a] HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer; TOC=total organic carbon. No entry indicates that the trend was not up.

The (uranium-sodium) bivariate plot for the Cell 5 LCS, LDS, and HTW is provided in Figure A.5.5–29. The plot shows that the chemical signature for uranium-sodium in the LCS LDS, and HTW are separate and distinct, indicating that mixing between the horizons is not occurring. Therefore, upward concentration trends measured beneath Cell 5 (i.e., in the HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

Vanadium:
In 2009, vanadium was identified for quarterly monitoring in Cell 5 only based on the outcome of the parameter selection process that was being conducted at the time. It was discovered this year that this designation was a mistake. The parameter selection process that was conducted for Cell 5 required a detection rate of at least 25 percent. Vanadium in the Cell 5 LCS only had a detection rate of 21 percent (See Table A.5.5–4 in the *Fernald Preserve 2009 Site Environmental Report* [DOE 2010]). A review of the data collected through 2012 indicates that vanadium still only has a detection rate of 21.7 percent in the LCS (Table A.5.5–1). It has never been detected in the LDS or HTW of Cell 5. Therefore, beginning in January 2014, vanadium will no longer be sampled for quarterly in Cell 5. It will continue to be sampled annually in the LCS.

A.5.5.2 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities –Unified Guidance* (EPA 2009) defines the process of creating a Shewart-CUSUM control chart. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected, the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared "out of control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit.

A minimum of eight samples are recommended for use in ChemStat software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat software plots both a CUSUM control limit (h) and a SCL on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL.

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat software though, by default, plots both the SCL and CUSUM (h) control limit on the charts. As a "work-a-round", the SCL limit was defined as five to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

As shown in Table A.5.5–1 in gray shading, six parameters in the HTW and/or GMA wells of Cell 5 (TOC, TDS, iron, sodium, sulfate, and zinc) meet the criteria for control charts (i.e., eight samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in seven control charts.

Parameter and Monitoring Point[a]	Assessment	Figure Number
TOC in the GMA-U	In Control	A.5.5–30
TDS in the GMA-D	**Out of Control**	A.5.5–31
Iron in the GMA-U	In Control	A.5.5–32
Sodium in the GMA-U	In Control	A.5.5–33
Sodium in the GMA-D	In Control	A.5.5–34
Sulfate in the GMA-D	In Control	A.5.5–35
Zinc in the GMA-D	In Control	A.5.5–36

[a] GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer; TOC = total organic carbon; TDS=total dissolved solids

These seven control charts are presented in Figures A.5.5–30 to A.5.5–36. All of the control charts, with the exception of one, exhibit "in control" conditions. The one exception is TDS in the GMA-downgradient well. As discussed above, separate and distinct signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 5 indicate that water is not mixing between the horizons, so the out of control conditions beneath the facility (i.e., HTW and GMA wells) are attributed to fluctuating ambient conditions beneath the cell, and not to cell performance.

A.5.5.3 Annual LCS Sample Results

Annual LCS sampling results for Cell 5 are provided in Table A.5.5–2 for those parameters that have been detected at least once and are not being sampled quarterly. No new Appendix I of PCB parameters were detected in the LCS of Cell 5 in 2012.

A.5.5.4 Summary and Conclusions

- Eleven parameters monitored quarterly have an upward concentration trend in the HTW and/or GMA wells of Cell 5: chloride, sulfate, TOC, arsenic, boron, iron, lithium, magnesium, manganese, selenium, and sodium.
- Separate and distinct chemical signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 5 indicate that water is not mixing between the horizons. Therefore, upward concentration trends beneath Cell 5 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell and not to cell performance.
- Seven control charts were constructed for Cell 5 parameters. Six of the seven control charts exhibit "in control" conditions. The control chart for TDS in the GMA-D well "out of control."
- No new Appendix I or PCB parameters were detected in the LCS of Cell 5 in 2012.
- In 2009, vanadium was identified for quarterly monitoring in Cell 5 only based on the outcome of the parameter selection process that was being conducted at the time. It was discovered this year that this designation was a mistake. The parameter selection process that was conducted for Cell 5 required a detection rate of at least 25 percent. Vanadium in the Cell 5 LCS only had a detection rate of 21 percent (See Table A.5.5-4 in the *2009 Fernald Preserve Site Environmental Report* (DOE 2010). A review of the data collected

through 2012 indicates that vanadium still only has a detection rate of 21.7 percent in the LCS (Table A.5.5–1). It has never been detected in the LDS or HTW of Cell 5. Therefore, beginning in January 2014, vanadium will no longer be sampled for quarterly in Cell 5. It will continue to be sampled annually in the LCS.

Table A.5.5–1. Summary Statistics for Cell 5

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Total Uranium (µg/L)	LCS	12342C	40	40	100	3.39	285	122	50	Undefined	None	Detected	
	LDS	12342D	36	36	100	2.93	27.1	16.1	5.3	Normal	None	Detected	
	HTW	12342	43	43	100	7.45	19.2	9.51	2.42	Undefined	None	Detected	
	GMA-U	22207	37	44	84.1	ND	2.39	0.27	0.34	Undefined	Down	Detected	
	GMA-D	22208	38	45	84.4	ND	2.1	0.375	0.294	Undefined	None	Not Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12342C	23	23	100	58	563	448	119	Undefined	None	Detected	
	LDS	12342D	16	16	100	102	651	490	214	Undefined	None	Detected	
	GMA-U	22207	8	8	100	337	370	355	12	Normal	None	Not Detected	
	GMA-D	22208	8	8	100	392	430	413	13	Normal	None	Not Detected	
Chloride (mg/L)	LCS	12342C	23	23	100	16.9	113	94.7	28.7	Undefined	Up	Detected	
	LDS	12342D	16	16	100	6.2	59.9	43.6	12.1	Undefined	Up	Detected	
	GMA-U	22207	8	8	100	20.5	41.5	29.8	6.3	Normal	Up	Not Detected	
	GMA-D	22208	8	8	100	21.5	31.9	25.7	3.4	Normal	None	Not Detected	
Nitrate, Nitrite (mg/L)	LCS	12342C	22	29	75.9	ND	4.18	1.28	0.98	Undefined	None	Detected	
	LDS	12342D	8	16	50.0	ND	2.01	1.66	0.76	LogNormal	Up	Detected	
	GMA-U	22207	1	8	12.5	ND	0.0425	Insufficient	Insufficient	Normal	None	Not Detected	
	GMA-D	22208	1	8	12.5	ND	0.050	Insufficient	Insufficient	Normal	None	Not Detected	
Sulfate (mg/L)	LCS	12342C	40	40	100	218	4070	2680	1210	Undefined	Up	Detected	5910 (Q3-10)
	LDS	12342D	36	36	100	1130	3630	1860	730	Undefined	Up	Detected	
	HTW	12342	34	34	100	101	399	264	112	Undefined	Up	Detected	
	GMA-U	22207	39	39	100	97.8	770	259	134	LogNormal	Up	Detected	
	GMA-D	22208	39	39	100	221	671	388	101	Normal	None	Not Detected	
Total Dissolved Solids (mg/L)	LCS	12342C	28	28	100	436	6350	5400	2140	Undefined	Up	Detected	
	LDS	12342D	14	14	100	2080	5650	4290	890	Normal	Up	Detected	
	GMA-U	22207	15	15	100	552	987	641	110	Undefined	Down	Detected	
	GMA-D	22208	15	15	100	882	1290	1020	120	Normal	None	Not Detected	
Total Organic Carbon (mg/L)	LCS	12342C	31	39	79.5	ND	4.21	1.98	0.84	Normal	None	Not Detected	
	LDS	12342D	33	36	91.7	ND	10.7	5.92	2.29	Normal	None	Detected	
	GMA-U	22207	33	44	75.0	ND	4.15	1.49	0.64	LogNormal	None	Not Detected	
	GMA-D	22208	34	44	77.3	ND	2.68	1.48	0.50	Normal	Up	Detected	8.93(Q4-01)
Total Organic Halogens (mg/L)	LCS	12342C	22	40	55.0	ND	0.0604	0.0112	0.0120	Undefined	None	Not Detected	
	LDS	12342D	26	36	72.2	ND	0.0717	0.0297	0.0195	Normal	None	Not Detected	
	GMA-U	22207	12	44	27.3	ND	0.0470	0.00296	0.00783	Undefined	Down	Detected	
	GMA-D	22208	10	44	22.7	ND	0.0167	0.00353	0.00460	Undefined	Down	Detected	
Arsenic (mg/L)	LCS	12342C	7	28	25.0	ND	0.140	0.0160	0.0347	Undefined	None	Not Detected	
	LDS	12342D	2	23	8.7	ND	0.0187	Insufficient	Insufficient	Undefined	None	Not Detected	
	HTW	12342	10	24	41.7	ND	0.0528	0.00368	0.0107	Undefined	None	Not Detected	
	GMA-U	22207	7	15	46.7	ND	0.0363	0.0025	0.0099	Undefined	None	Not Detected	
	GMA-D	22208	5	28	17.9	ND	0.0390	0.0025	0.0103	Undefined	Up	Detected	
Barium (mg/L)	LCS	12342C	23	23	100	0.0155	0.0707	0.0303	0.0145	LogNormal	Down	Detected	
	LDS	12342D	16	16	100	0.00698	0.0659	0.0215	0.0141	LogNormal	Down	Detected	
	GMA-U	22207	8	8	100	0.0622	0.0752	0.0679	0.0052	Normal	None	Not Detected	
	GMA-D	22208	8	8	100	0.0417	0.0617	0.0490	0.0067	Normal	None	Not Detected	
Boron (mg/L)	LCS	12342C	38	40	95.0	ND	1.59	0.751	0.317	Undefined	None	Detected	
	LDS	12342D	36	36	100	0.202	1.20	0.388	0.287	Undefined	None	Detected	
	GMA-U	22207	39	44	88.6	ND	0.048	0.0382	0.0084	Undefined	Up	Not Detected	
	GMA-D	22208	38	44	86.4	ND	0.0469	0.0318	0.0098	Normal	Up	Detected	

Table A.5.5–1 (continued). Summary Statistics for Cell 5

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Calcium (mg/L)	LCS	12342C	23	23	100	163	990	519	150	Undefined	None	Not Detected	
	LDS	12342D	16	16	100	222	386	312	44	Normal	None	Not Detected	
	GMA-U	22207	8	8	100	124	187	152	18	Normal	None	Not Detected	
	GMA-D	22208	8	8	100	222	285	244	22	Normal	None	Not Detected	
Cobalt (mg/L)	LCS	12342C	13	28	46.4	ND	0.0116	0.00050	0.00298	Undefined	None	Detected	
	LDS	12342D	10	23	43.5	ND	0.0034	0.00067	0.00087	Undefined	Down	Detected	
	GMA-U	22207	0	15	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22208	0	15	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Copper (mg/L)	LCS	12342C	16	24	66.7	ND	0.0343	0.0111	0.0081	Undefined	None	Not Detected	0.0862(Q4-02)
	LDS	12342D	9	18	50.0	ND	0.0209	0.0073	0.0063	Undefined	None	Not Detected	
	GMA-U	22207	6	8	75.0	ND	0.00993	0.0041	0.0035	Normal	None	Not Detected	
	GMA-D	22208	6	8	75.0	ND	0.00925	0.00215	0.00347	Undefined	Down	Detected	
Iron (mg/L)	LCS	12342C	24	28	85.7	ND	4.61	0.258	1.56	Undefined	Down	Detected	
	LDS	12342D	22	23	95.6	ND	3.67	1.01	1.06	Undefined	Down	Not Detected	
	GMA-U	22207	15	15	100	5.54	18.2	9.44	4.17	LogNormal	None	Not Detected	
	GMA-D	22208	15	15	100	4.92	8.60	7.09	1.01	Normal	Up	Detected	
Lithium (mg/L)	LCS	12342C	24	24	100	0.107	0.576	0.205	0.098	LogNormal	Up	Detected	
	LDS	12342D	22	22	100	0.0484	0.229	0.132	0.060	Undefined	Up	Detected	
	GMA-U	22207	15	15	100	0.00642	0.0141	0.0112	0.0029	Undefined	Up	Detected	
	GMA-D	22208	15	15	100	0.00659	0.00932	0.0080	0.0008	Normal	None	Detected	
Magnesium (mg/L)	LCS	12342C	23	23	100	57.7	913	504	277	Undefined	Up	Detected	
	LDS	12342D	16	16	100	104	458	114	148	Undefined	Up	Detected	
	GMA-U	22207	8	8	100	26.1	36.2	30.2	3.1	Normal	None	Not Detected	
	GMA-D	22208	8	8	100	52.5	66.4	58.7	5.0	Normal	Up	Not Detected	
Manganese (mg/L)	LCS	12342C	13	28	46.4	ND	2.96	0.00805	0.926	Undefined	None	Detected	
	LDS	12342D	17	23	73.9	ND	0.783	0.0367	0.174	Undefined	Down	Not Detected	
	GMA-U	22207	15	15	100	0.256	0.650	0.329	0.096	Undefined	None	Not Detected	
	GMA-D	22208	27	28	96.4	ND	0.513	0.386	0.094	Undefined	Up	Not Detected	
Nickel (mg/L)	LCS	12342C	24	28	85.7	ND	0.0452	0.00459	0.0155	Undefined	Down	Detected	
	LDS	12342D	21	23	91.3	ND	0.0230	0.00375	0.00612	Undefined	Down	Detected	
	GMA-U	22207	0	15	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22208	8	28	28.6	ND	0.0069	0.00075	0.00166	Undefined	None	Detected	
Potassium (mg/L)	LCS	12342C	23	23	100	6.22	65.5	26.8	10.5	Undefined	Up	Detected	
	LDS	12342D	16	16	100	10	42.7	14.4	11.0	Undefined	Up	Detected	
	GMA-U	22207	8	8	100	2.75	3.23	2.99	0.18	Normal	None	Not Detected	
	GMA-D	22208	8	8	100	3.13	3.41	3.26	0.11	Normal	None	Not Detected	
Selenium (mg/L)	LCS	12342C	7	28	25.0	ND	0.212	0.00625	0.0417	Undefined	None	Not Detected	
	LDS	12342D	2	23	8.7	ND	0.0525	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-U	22207	1	15	6.7	ND	0.00509	Insufficient	Insufficient	Undefined	None	Detected	
	GMA-D	22208	1	15	6.7	ND	0.0107	Insufficient	Insufficient	Undefined	Up	Not Detected	

Table A.5.5−1 (continued). Summary Statistics for Cell 5

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Sodium (mg/L)	LCS	12342C	27	28	96.4	ND	108	70.4	18.4	Undefined	Up	Not Detected	
	LDS	12342D	23	23	100	84.6	564	389	97	Undefined	Up	Detected	
	HTW	12342	24	24	100	17.0	33.6	28.6	5.2	Undefined	Up	Detected	
	GMA-U	22207	15	15	100	13.0	17.1	14.7	1.1	Normal	None	Not Detected	
	GMA-D	22208	15	15	100	14.3	17.7	16.2	1.0	Normal	None	Not Detected	
Vanadium (mg/L)	LCS	12342C	5	23	21.7	ND	0.12500	0.00124	0.0257	Undefined	None	Detected	
	LDS	12342D	0	16	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	HTW	12342	0	10	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-U	22207	0	8	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22208	1	8	12.5	ND	0.00186	Insufficient	Insufficient	Undefined	None	Not Detected	
Zinc (mg/L)	LCS	12342C	10	28	35.7	ND	0.040	0.0136	0.0087	LogNormal	None	Not Detected	
	LDS	12342D	17	23	73.9	ND	0.131	0.0324	0.0288	LogNormal	None	Not Detected	
	GMA-U	22207	5	15	33.3	ND	0.0123	0.0047	0.0039	Undefined	None	Not Detected	
	GMA-D	22208	16	28	57.1	ND	0.0043	0.0042	0.0026	LogNormal	None	Not Detected	

Note 1: Shading identifies a horizontal till well or Great Miami Aquifer well, with more than 8 samples, normal or lognormal distribution, no trend, and no serial correlation. These wells meet control chart criteria.

Note 2: Data used in this table has been standardized to quarterly.

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]ND = not detected; NA = not applicable

[c]Averages were determined based on the distribution assumption.

[d]Insufficient is used for Distribution Type, Trend, or Serial Correlation whenever there is not enough data to run the test, for average whenever there is less than 4 detetions, and for standard deviation whenever there are less than 5 detections.

[e]Data distribution based on the Shapiro-Wilk statistic.

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[f]Trend based on nonparametric Mann-Kendall procedure.

[g]Serial correlation based on Rank Von Neumann test.

[h]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 25).

[i]Q = quarterly

Table A.5.5–2. Cell 5 Annual LCS Sample Summary Information for Detected Parameters

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	DETECTED IN 2012	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)
General Chemistry											
Ammonia (mg/L)	11	3	27.3	No	0.02	0.815	0.291	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganics											
Beryllium (mg/L)	11	1	9.1	No	0.000038	-	-	0.004 mg/L(0)	-	-	0.0343 mg/L(0)
Chromium (mg/L)	11	2	18.2	No	0.0013	0.00457	0.0029	0.022 mg/L[g](0)	0.021 mg/L(0)	0.0046 mg/L(0)	0.818 mg/L(0)
Radionuclides											
Technetium-99 (pCi/L)	19	8	42.1	No	2.04	19	10.3	94 pCi/L(0)	22 pCi/L(0)	30 pCi/L(0)	6130 pCi/L(0)
Organics											
1,1-Dichloroethane (ug/L)	9	1	11.1	No	0.498	-	-	280 ug/L(0)	-	-	-
1,1-Dichloroethene (ug/L)	19	1	5.3	No	0.744	-	-	7 ug/L(0)	-	-	-
4-Methyl-2-Pentanone (ug/L)	9	1	11.1	No	0.46	-	-	-	-	-	-
Acetone (ug/L)	9	1	11.1	No	2.7	-	-	-	-	-	-
Carbon Disulfide (ug/L)	9	1	11.1	No	0.33	-	-	5.5 ug/L(0)	-	-	-
Toluene (ug/L)	9	1	11.1	No	0.416	-	-	-	-	-	-

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on hexavalent chromium from Operable Unit 5 Record of Decision, Table 9-4.

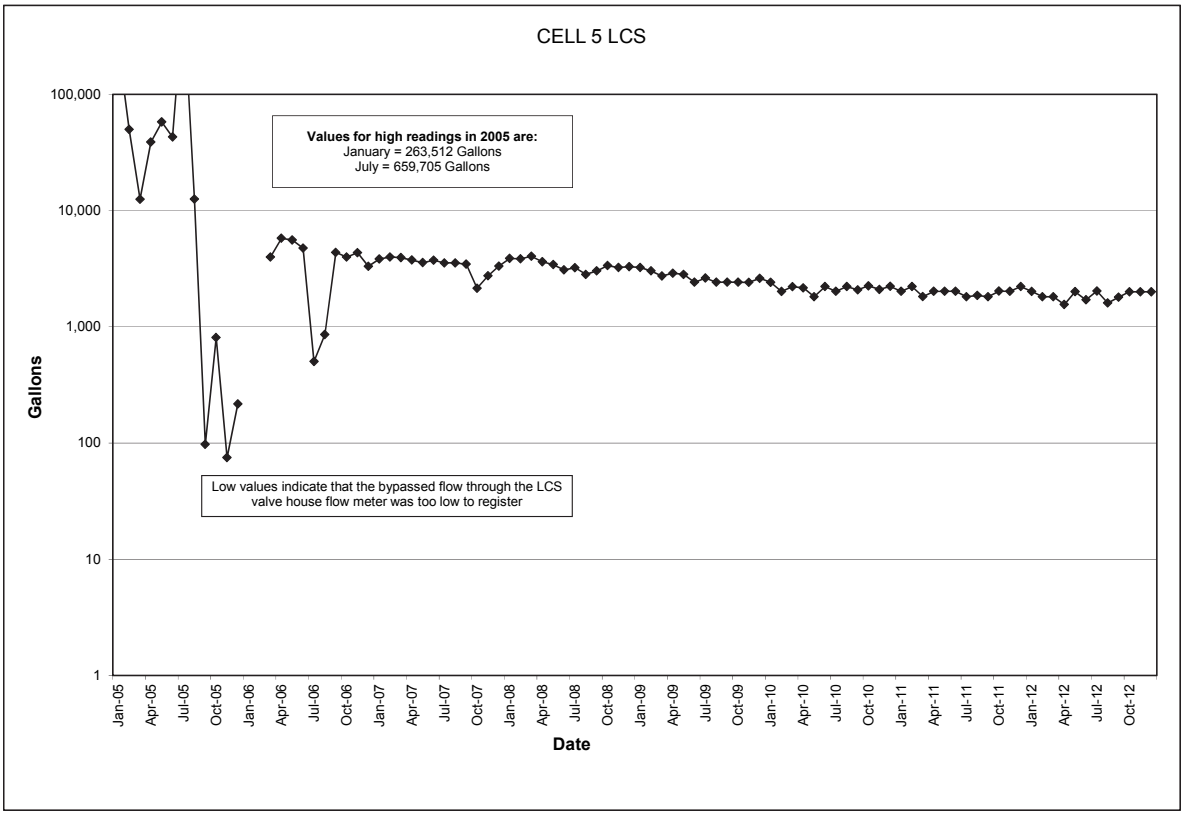


Figure A.5.5–1. Monthly Accumulation Volumes For Cell 5 LCS

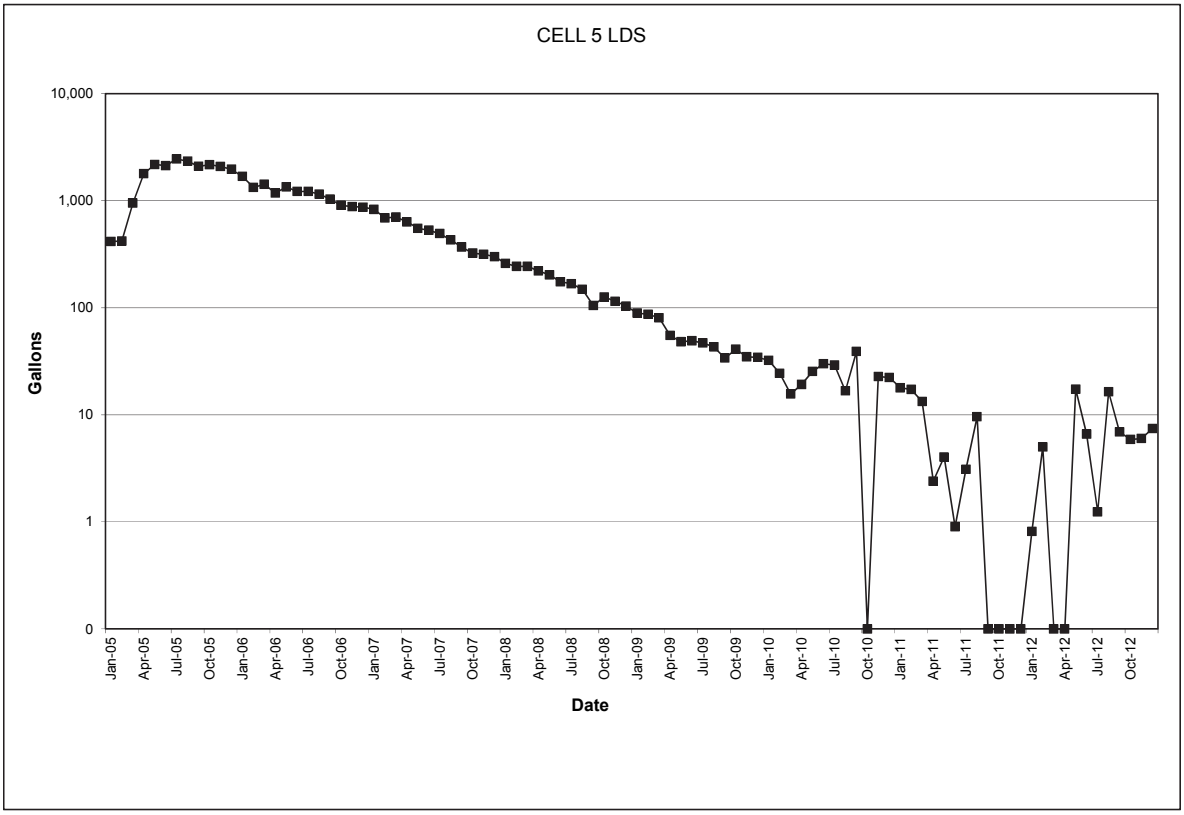
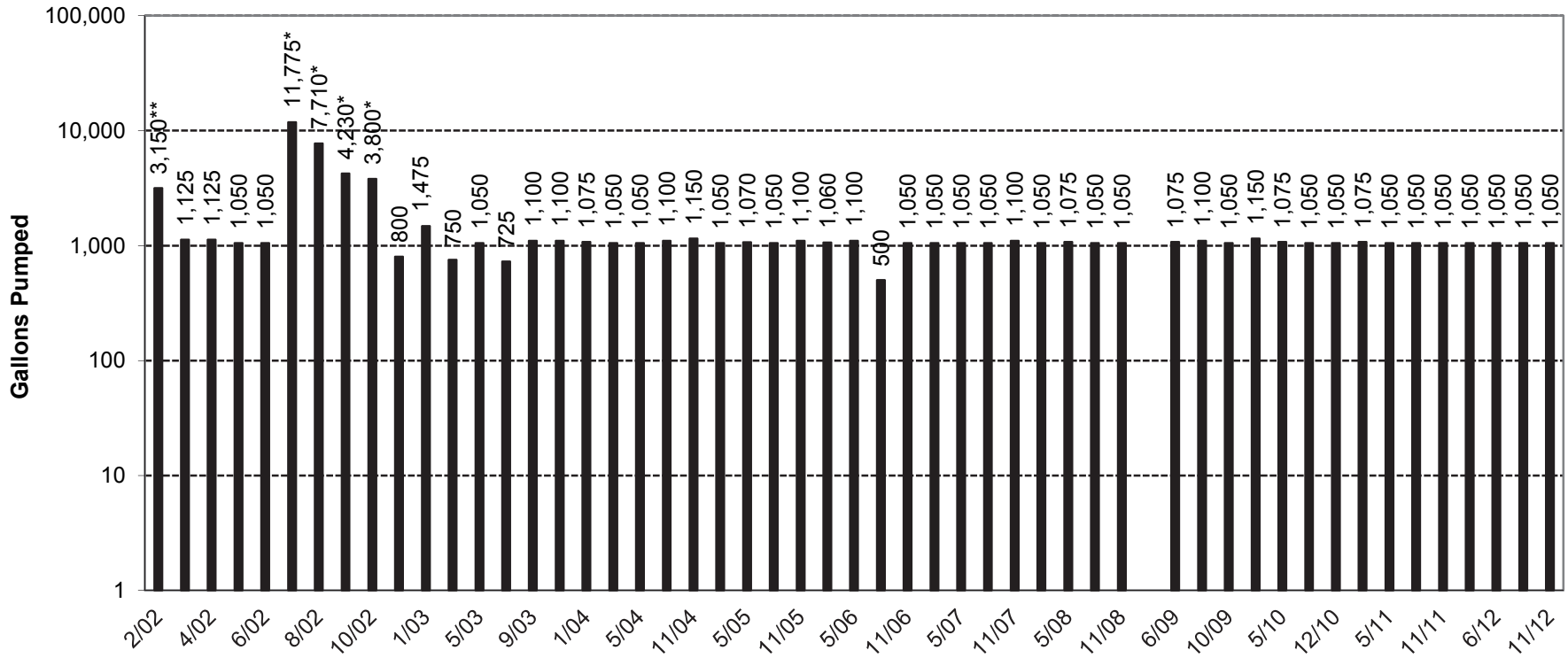


Figure A.5.5–2. Monthly Accumulation Volumes For Cell 5 LDS



12342 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
2002	35815	n=10	3582
2003:	6200	n=6	1033
2004:	5425	n=5	1085
2005:	4270	n=4	1068
2006:	3710	n=4	928
2007:	4250	n=4	1063
2008:	4225	n=4	1056
2009:	3225	n=3	1075
2010:	4325	n=4	1081
2011:	4225	n=4	1056
2012:	4200	n=4	1050
Overall:			1536

*More than one purge of the well was completed during these months to drain perched water and infiltrating surface water so the compacted clay liner could be constructed.

**Excess water was pumped from this well in February 2002 for well development.

Figure A.5.5–3. OSDF Horizontal Till Well 12342 (Cell 5) Water Yield

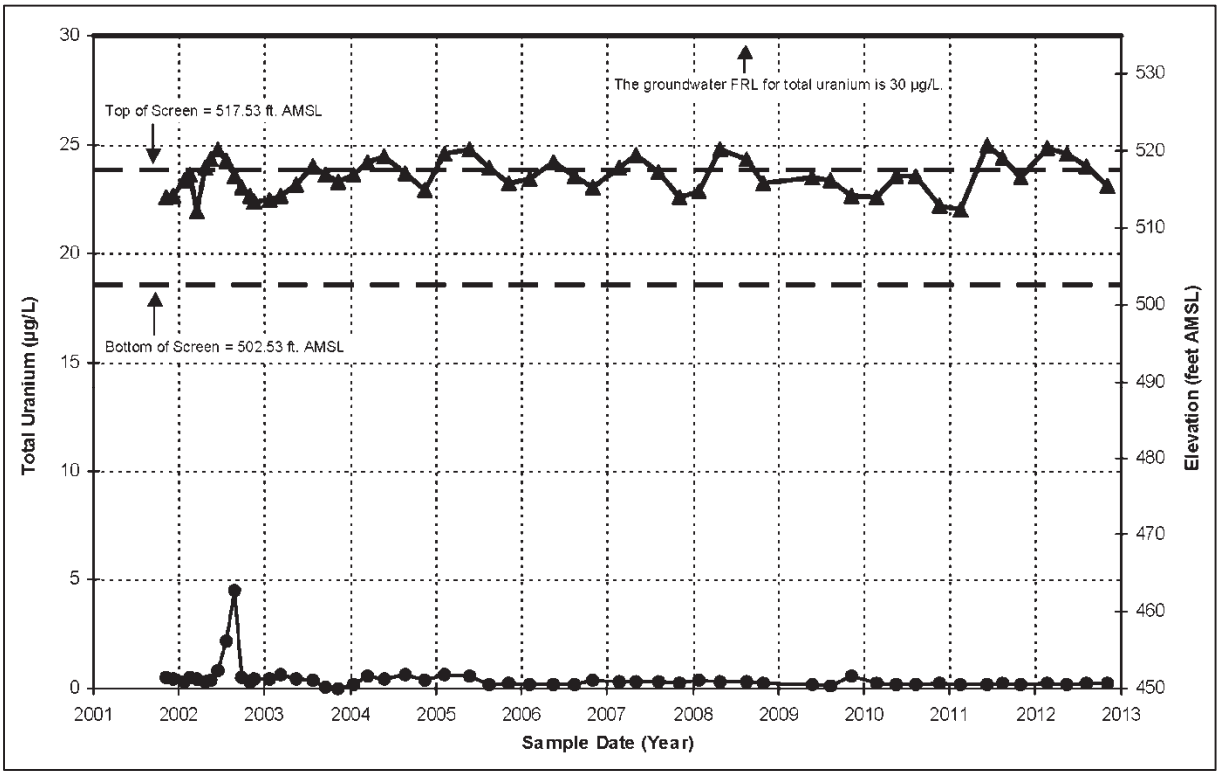


Figure A.5.5–4. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 5 Upgradient Monitoring Well 22207

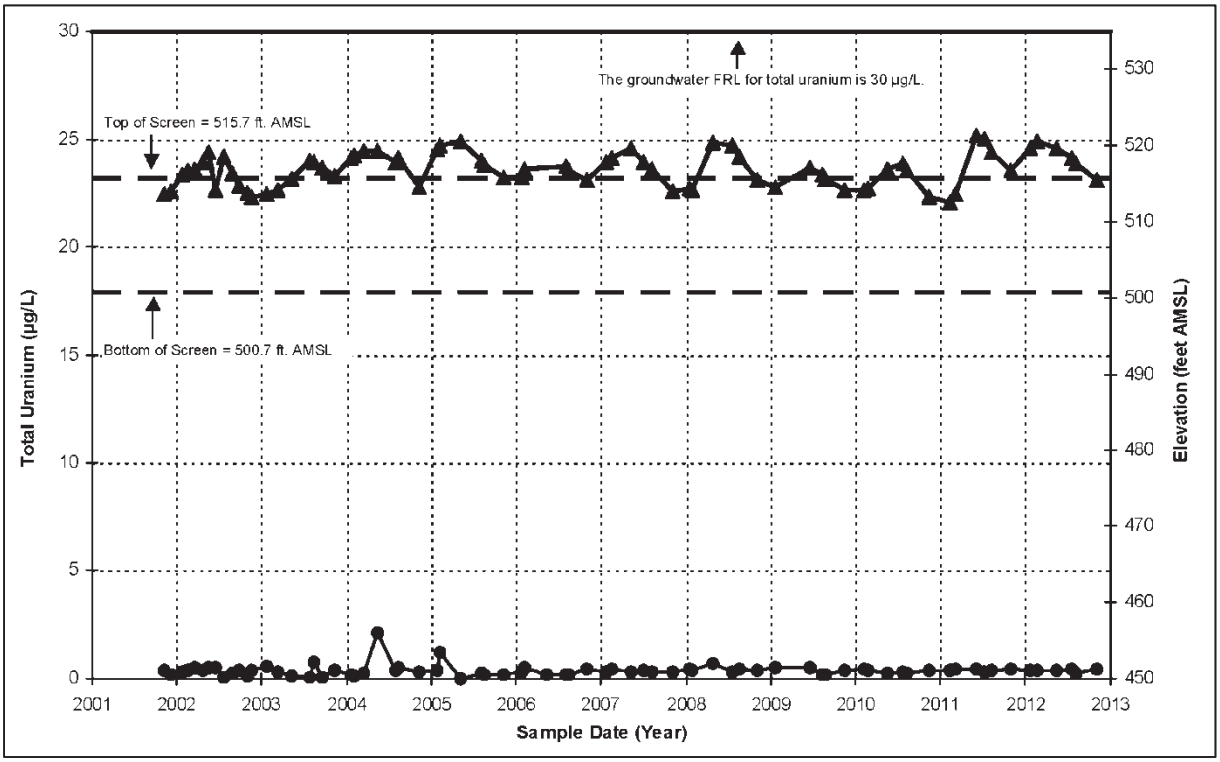


Figure A.5.5–5. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 5 Downgradient Monitoring Well 22208

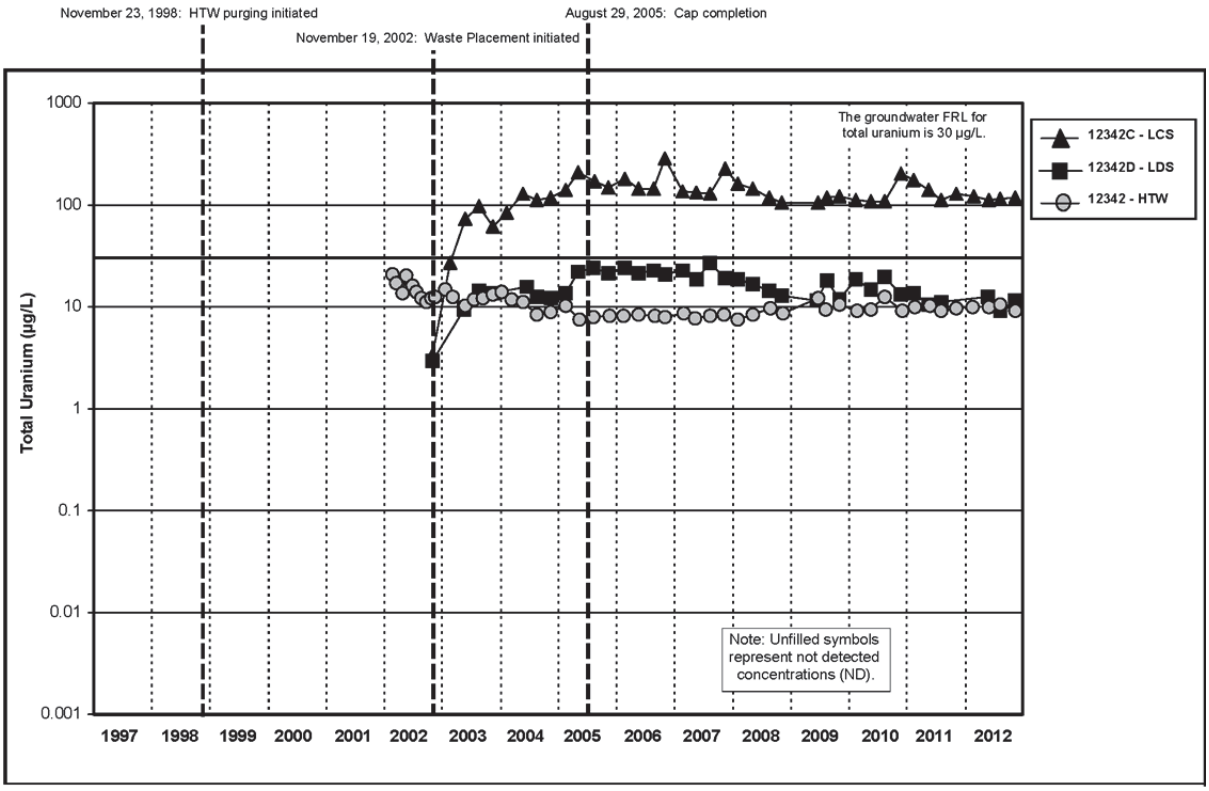


Figure A.5.5–6A. Cell 5 Uranium, Total Concentration vs. Time Plot for LCS, LDS, and HTW

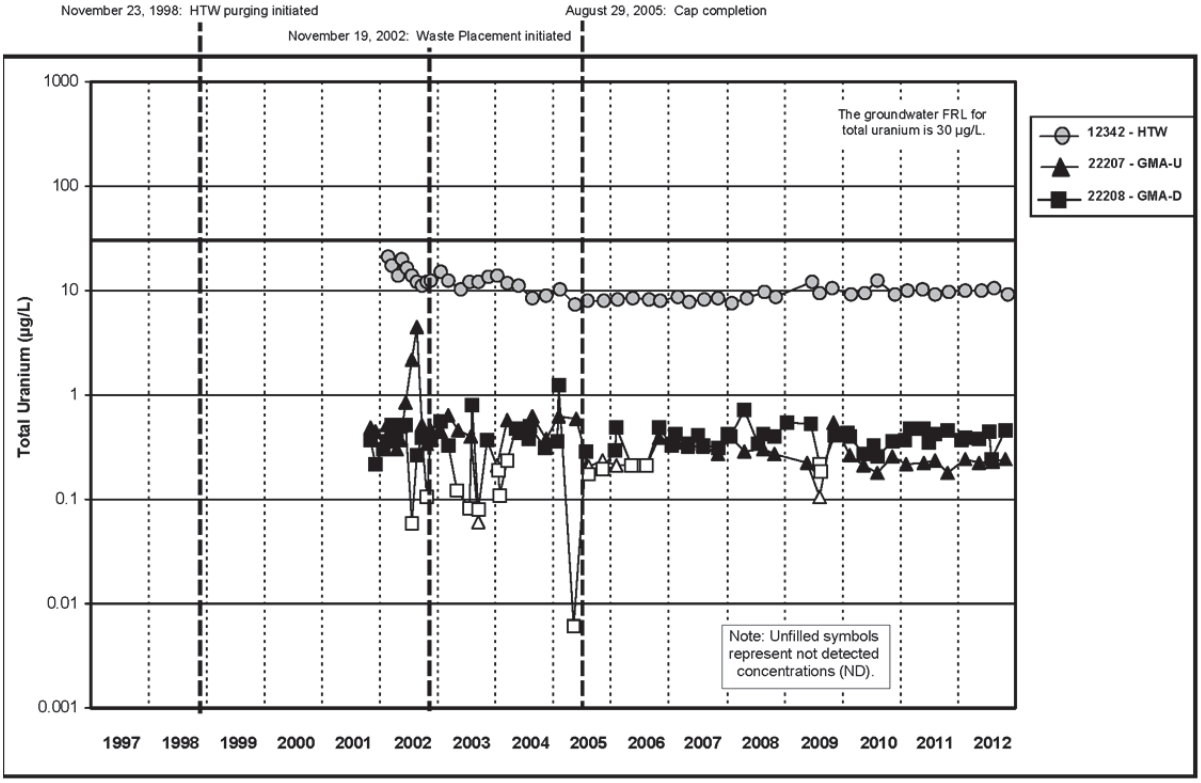


Figure A.5.5–6B. Cell 5 Uranium, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

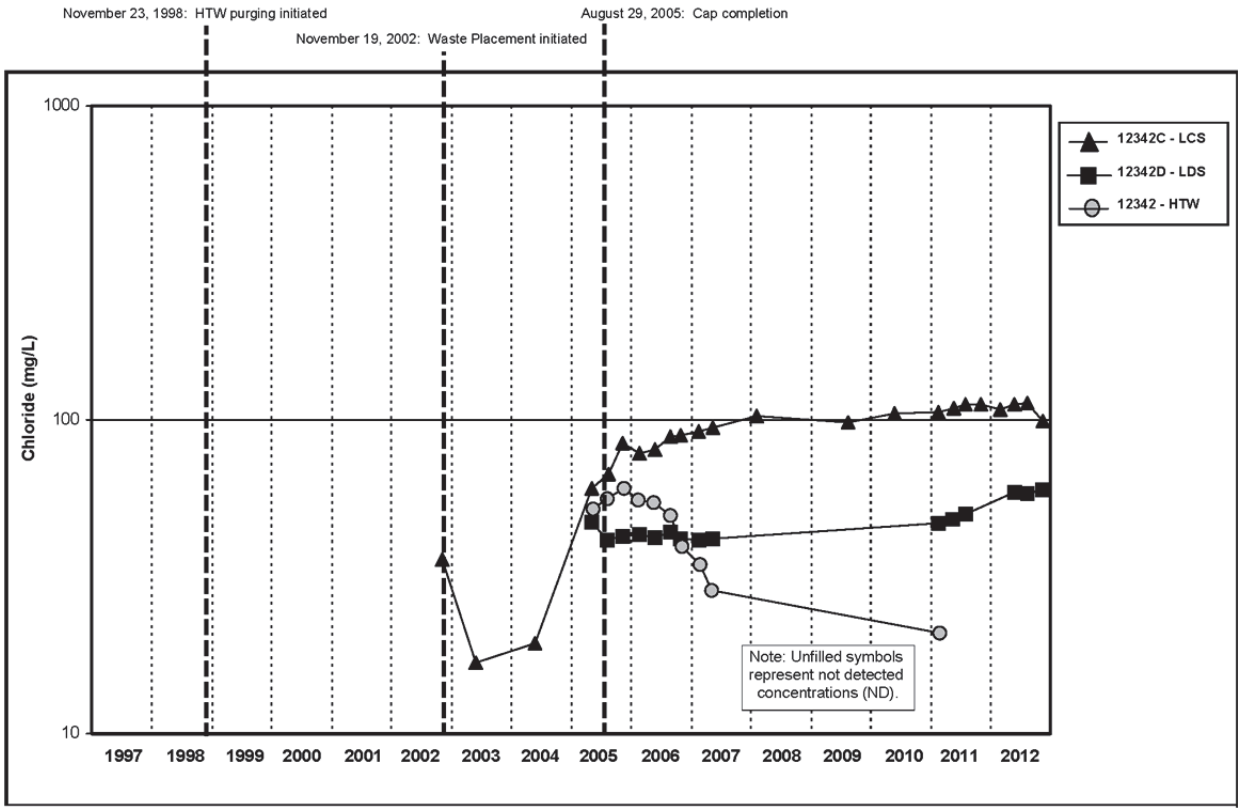


Figure A.5.5–7A. Cell 5 Chloride Concentration vs. Time Plot for LCS, LDS, and HTW

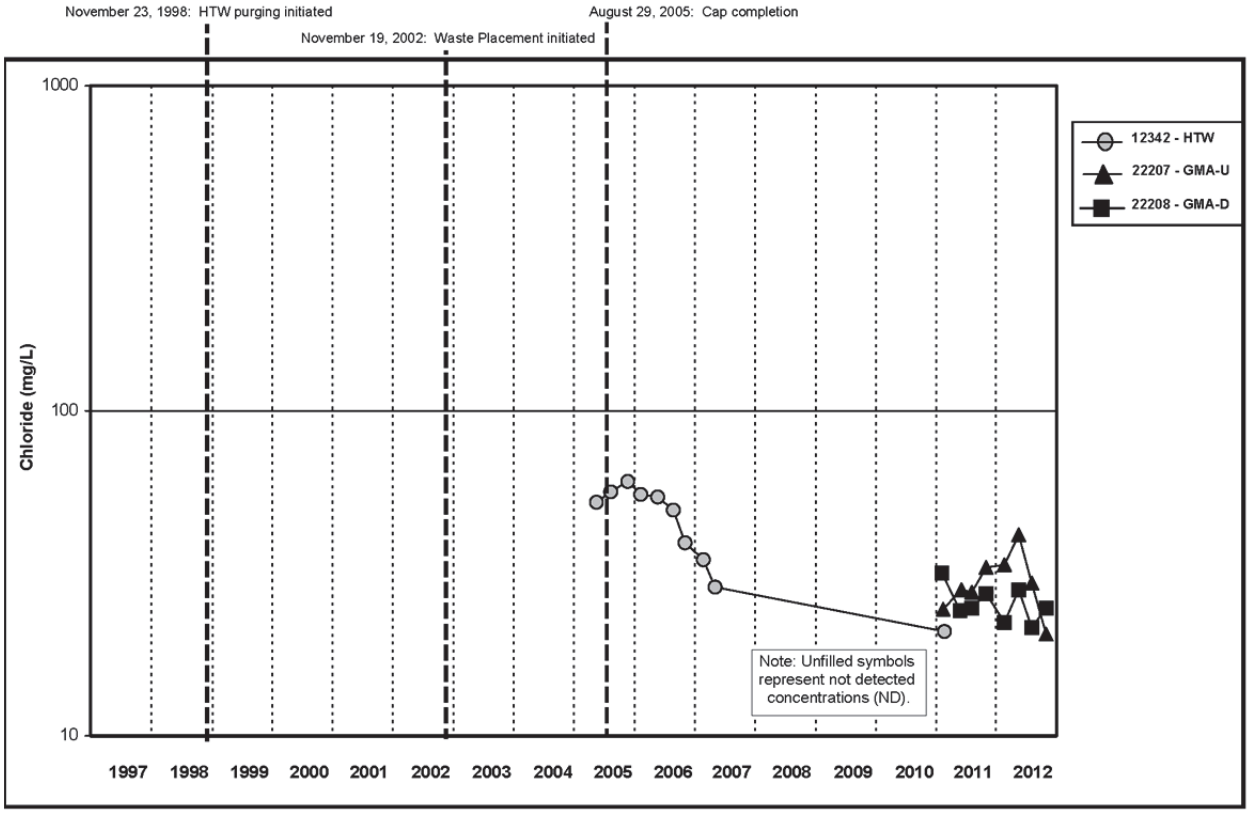


Figure A.5.5–7B. Cell 5 Chloride Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

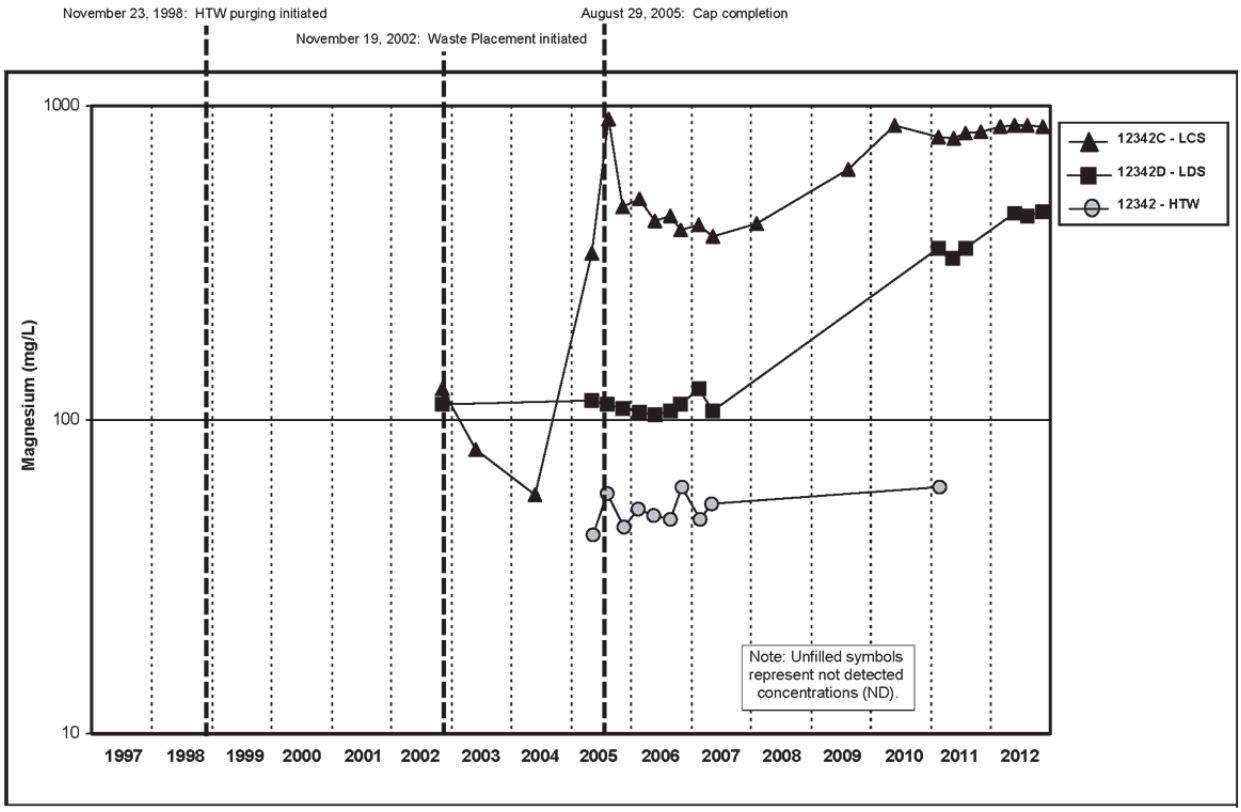


Figure A.5.5–8A. Cell 5 Magnesium Concentration vs. Time Plot for LCS, LDS, and HTW

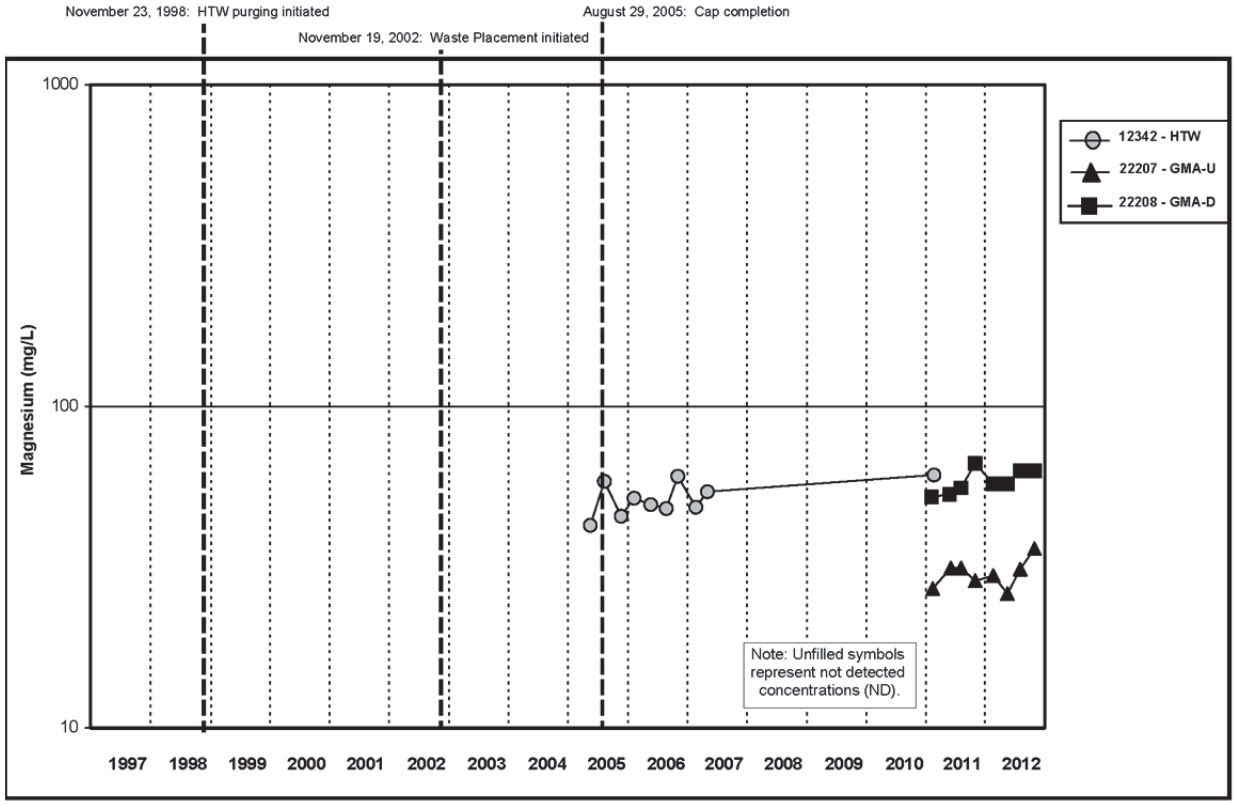


Figure A.5.5–8B. Cell 5 Magnesium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

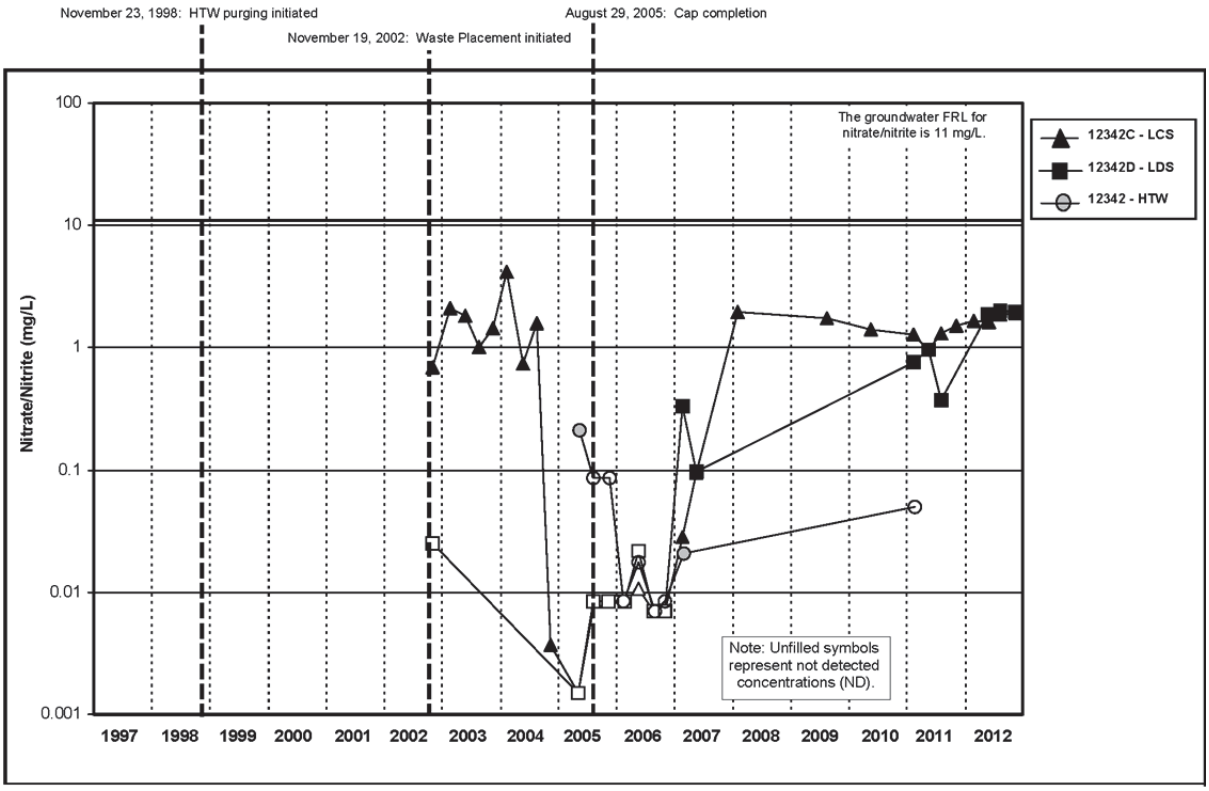


Figure A.5.5–9A. Cell 5 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for LCS, LDS, and HTW

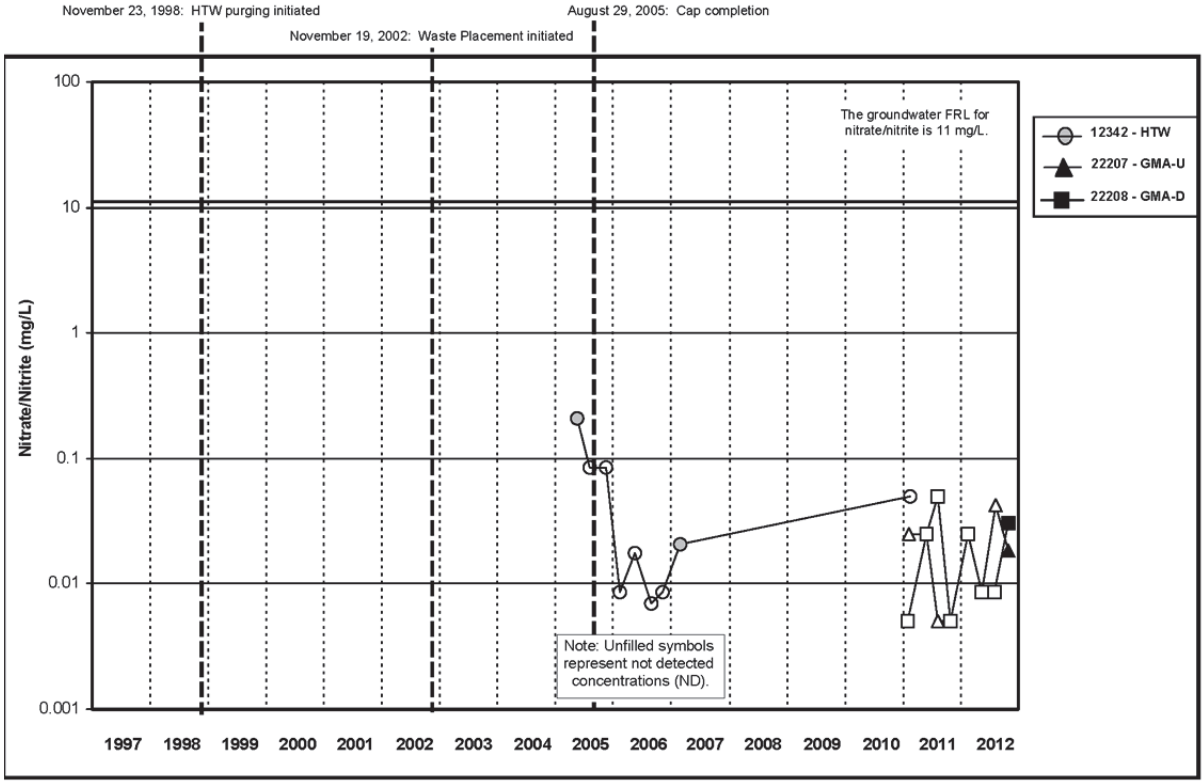


Figure A.5.5–9B. Cell 5 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

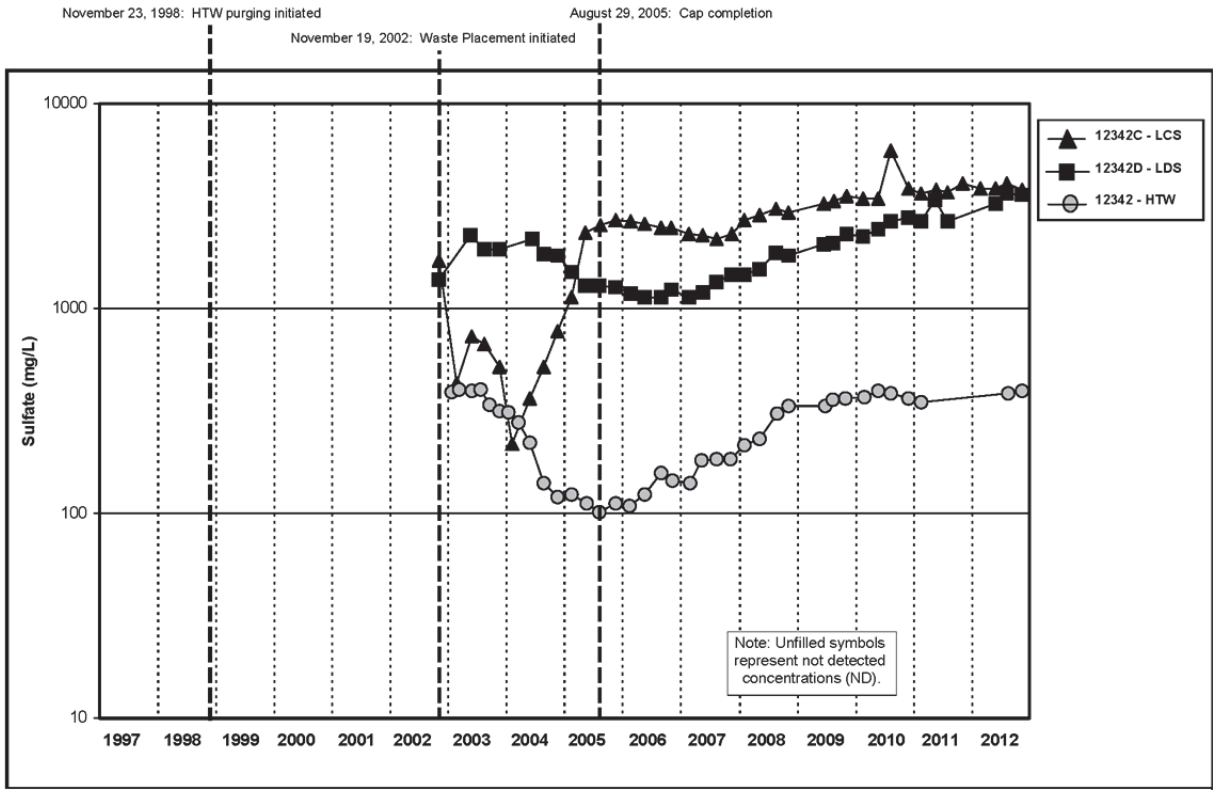


Figure A.5.5–10A. Cell 5 Sulfate Concentration vs. Time Plot for LCS, LDS, and HTW

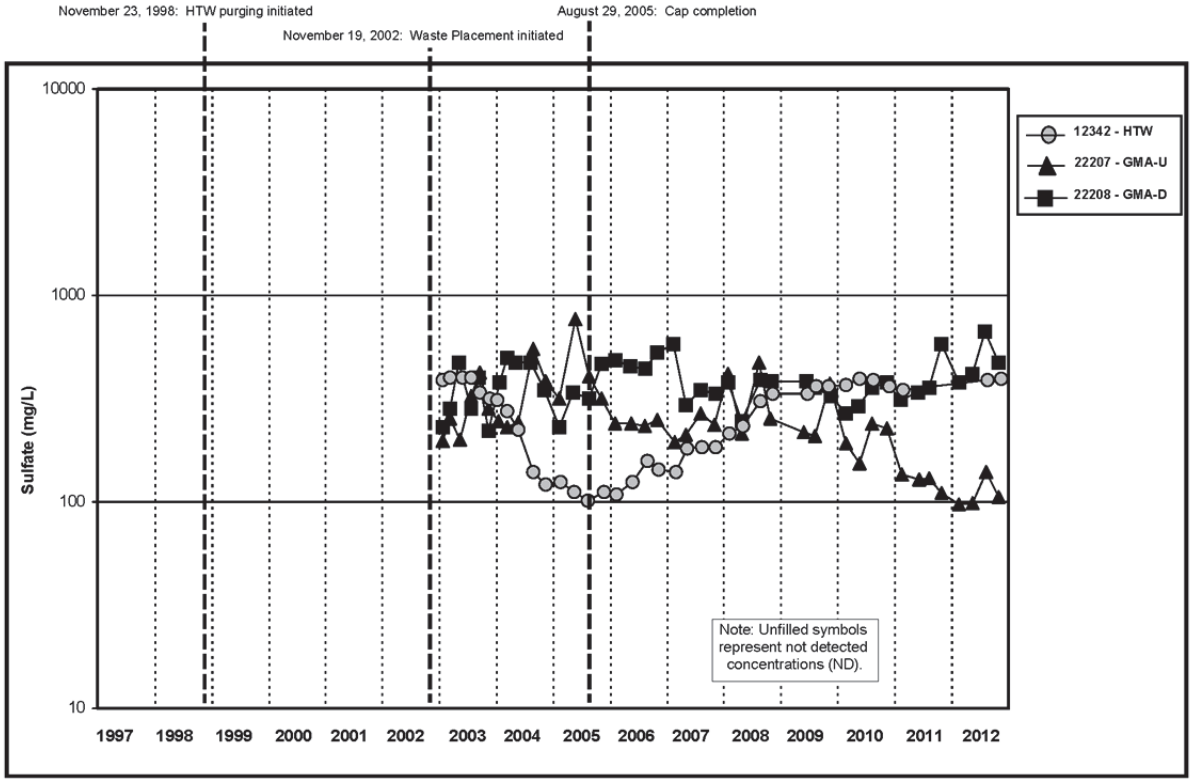


Figure A.5.5–10B. Cell 5 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

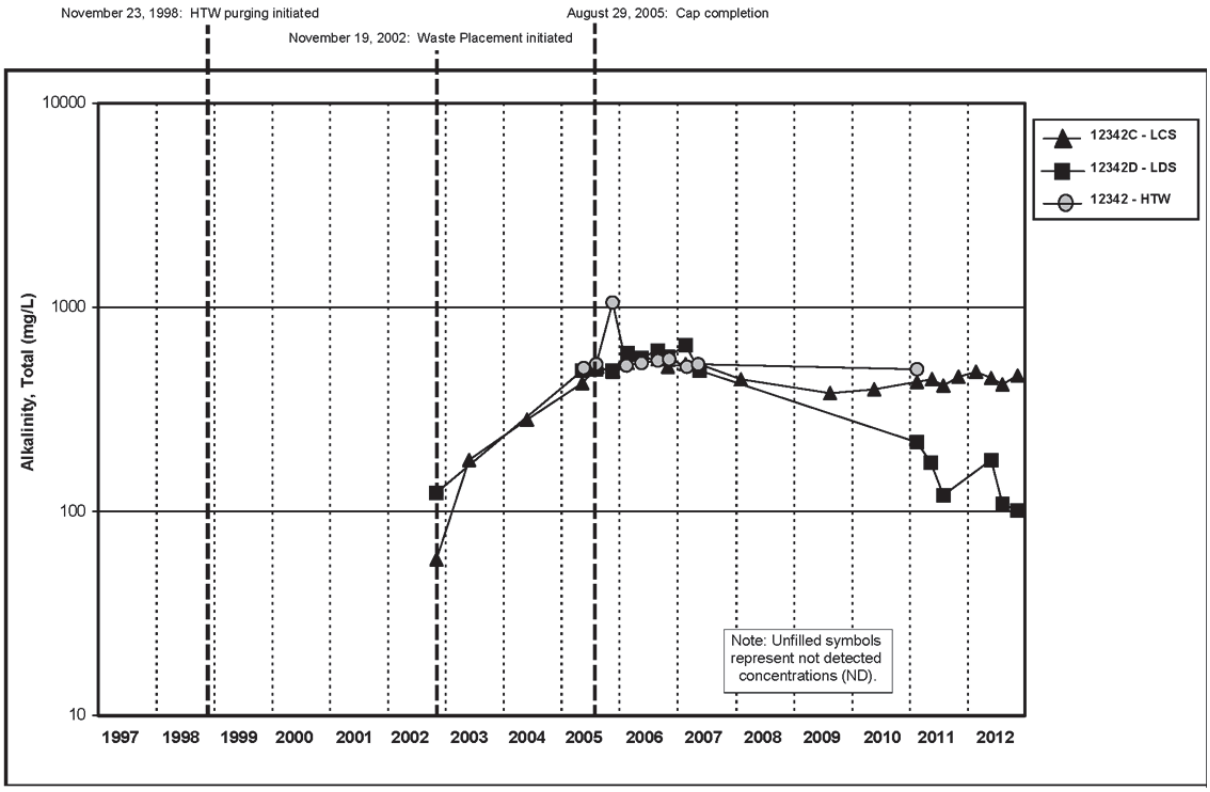


Figure A.5.5–11A. Cell 5 Alkalinity, Total Concentration vs. Time Plot for LCS, LDS, and HTW

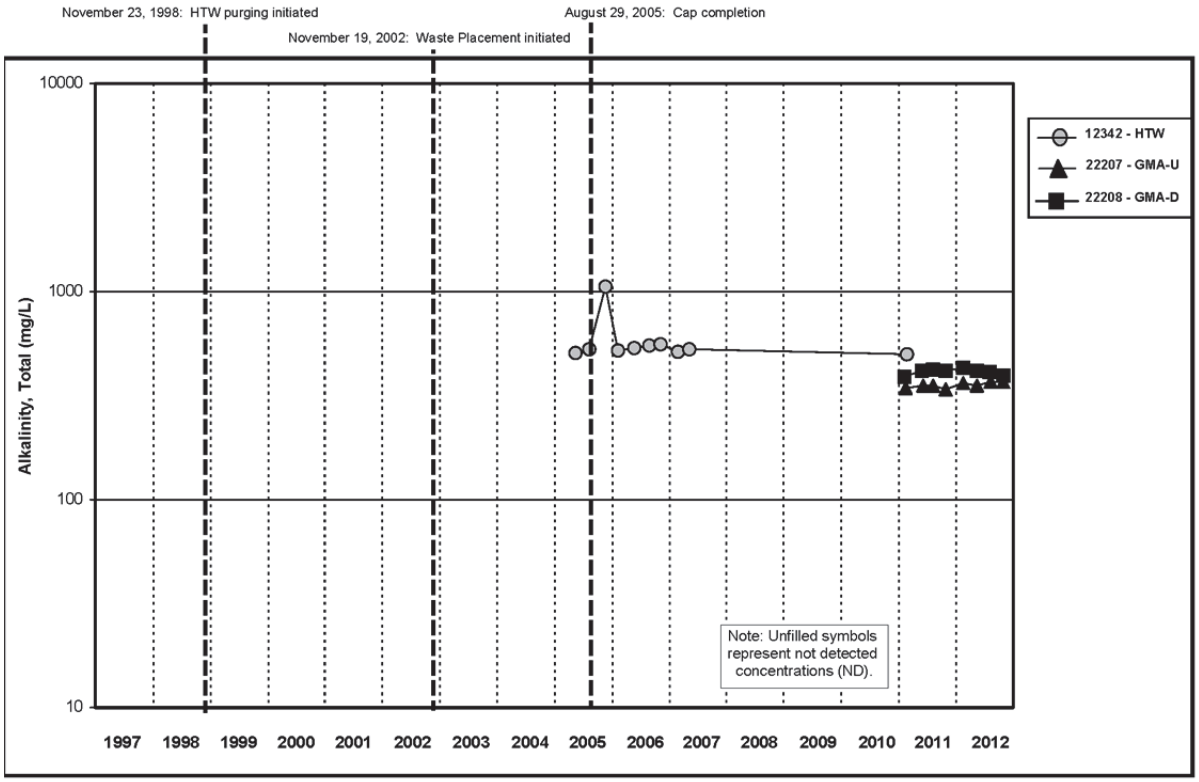


Figure A.5.5–11B. Cell 5 Alkalinity, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

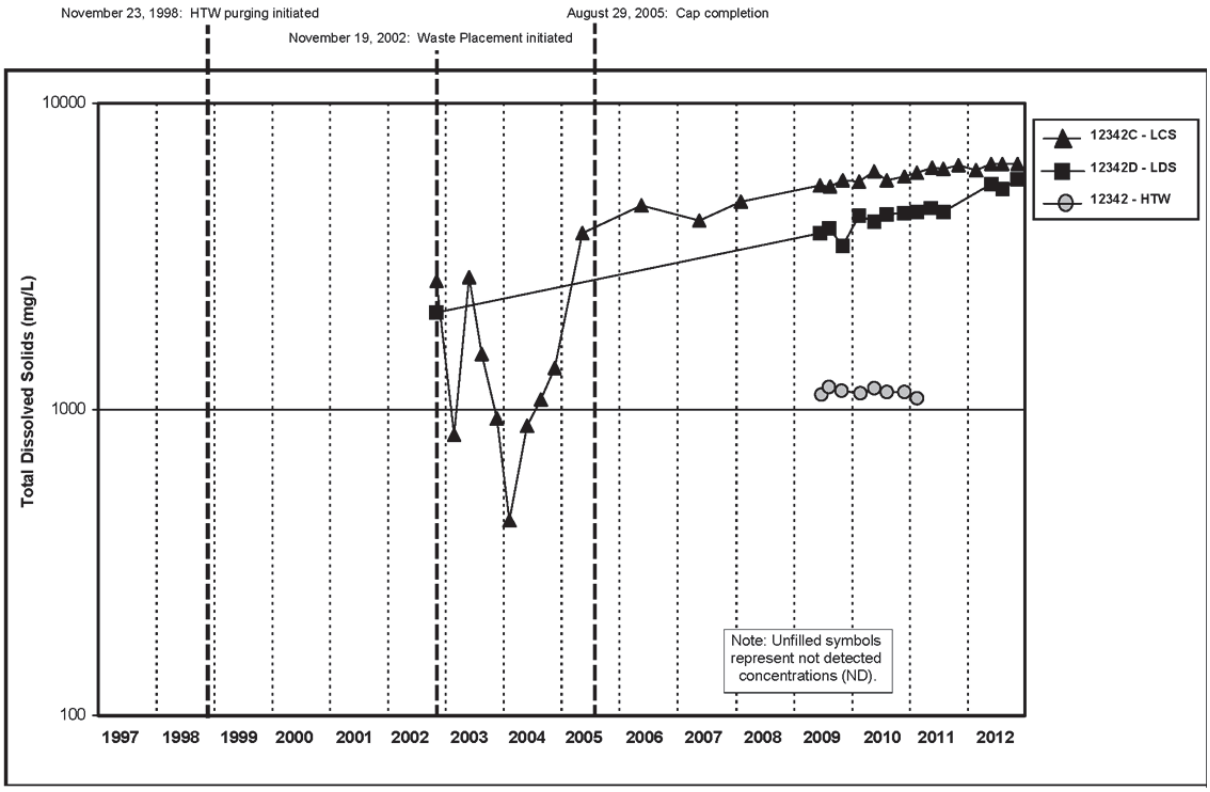


Figure A.5.5–12A. Cell 5 Total Dissolved Solids Concentration vs. Time Plot for LCS, LDS, and HTW

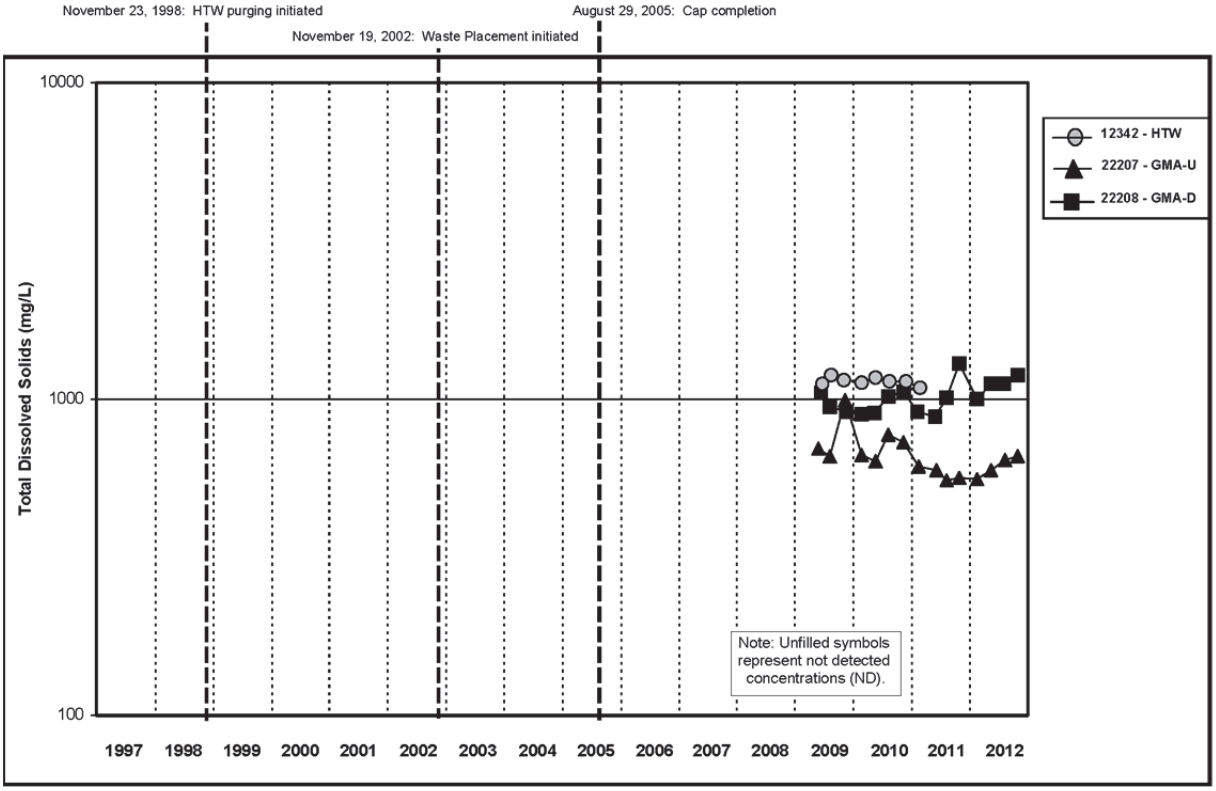


Figure A.5.5–12B. Cell 5 Total Dissolved Solids Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

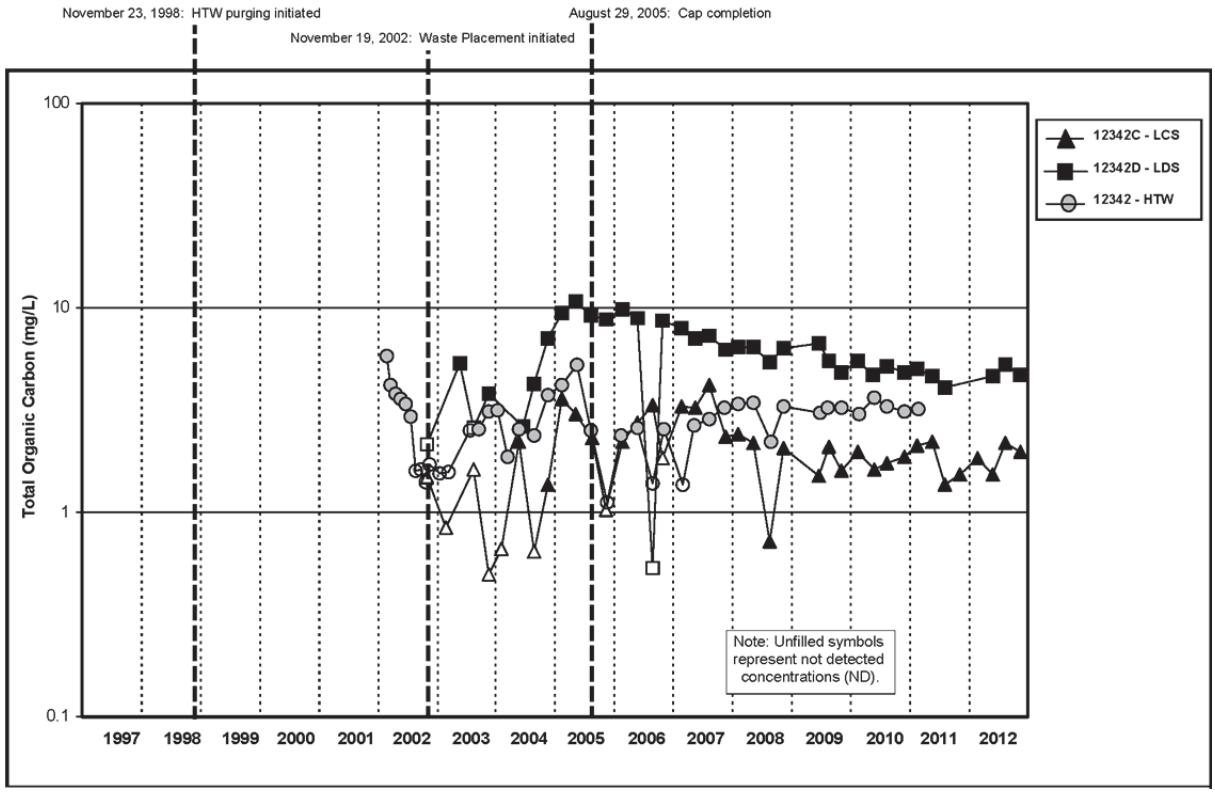


Figure A.5.5–13A. Cell 5 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, and HTW

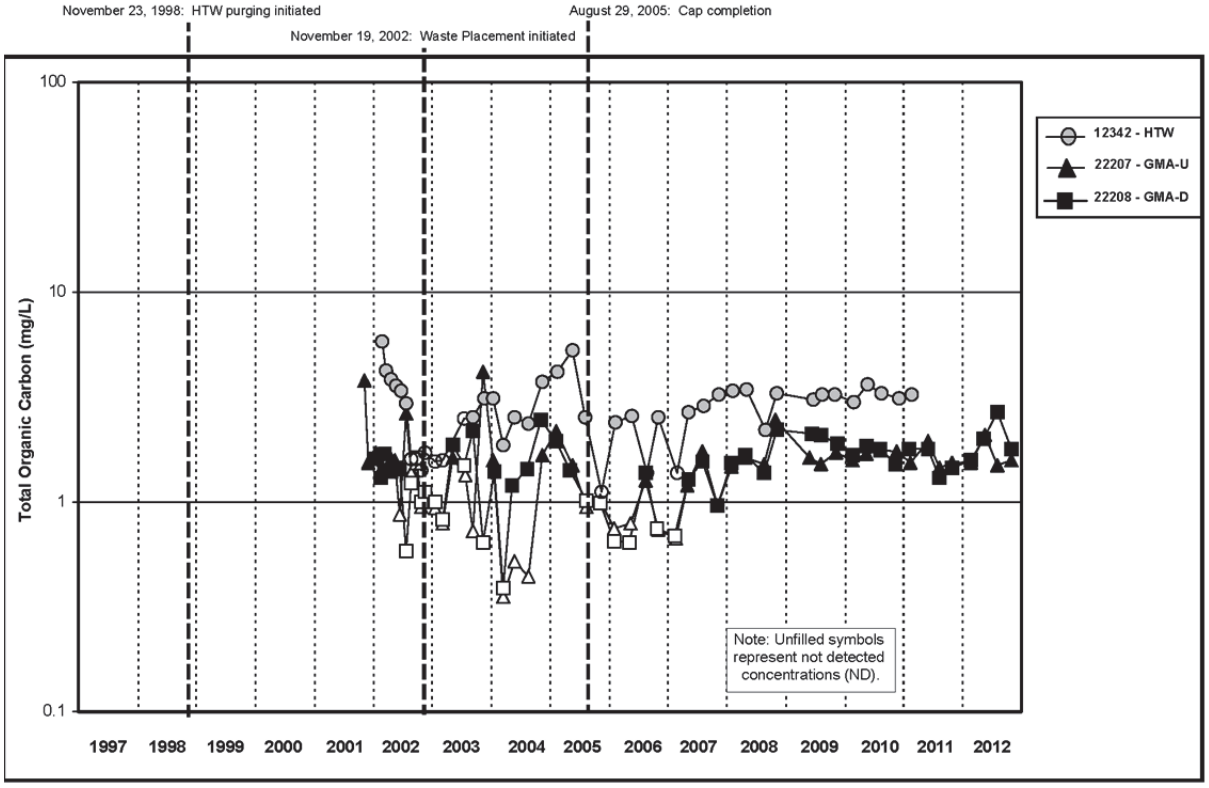


Figure A.5.5–13B. Cell 5 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

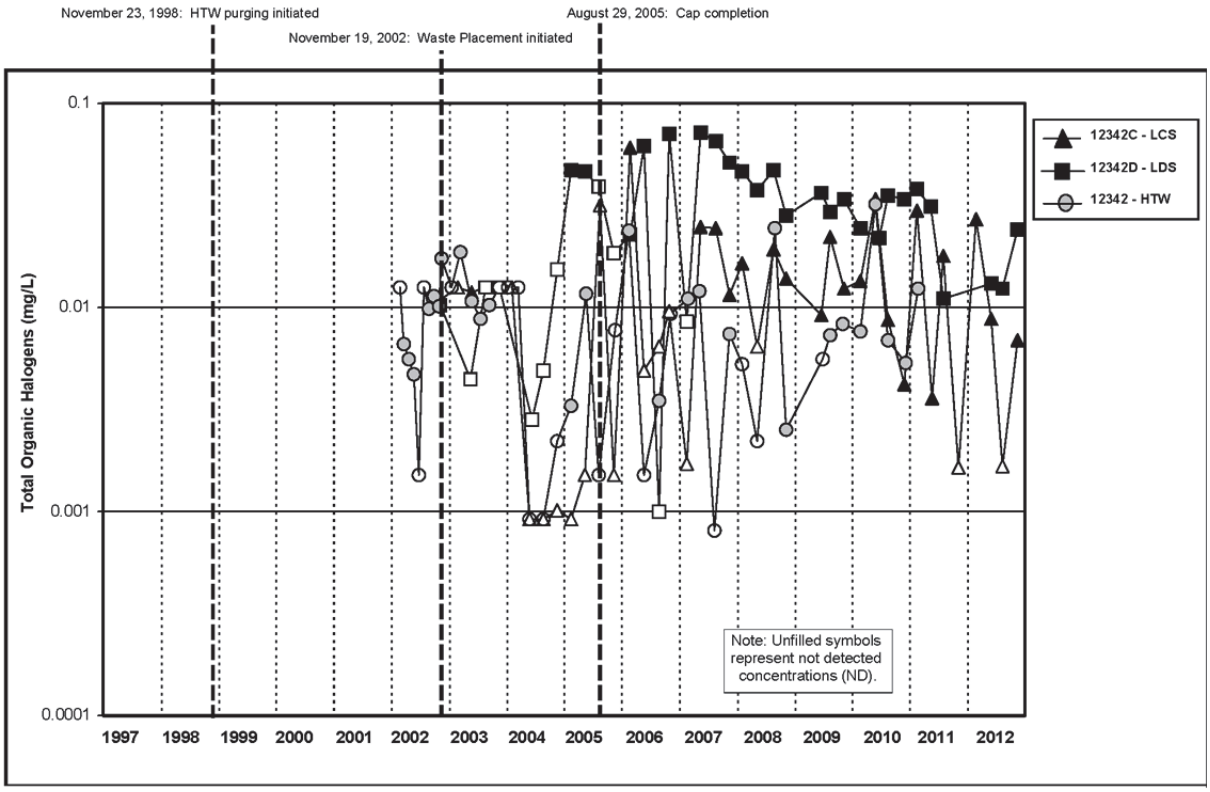


Figure A.5.5–14A. Cell 5 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, and HTW

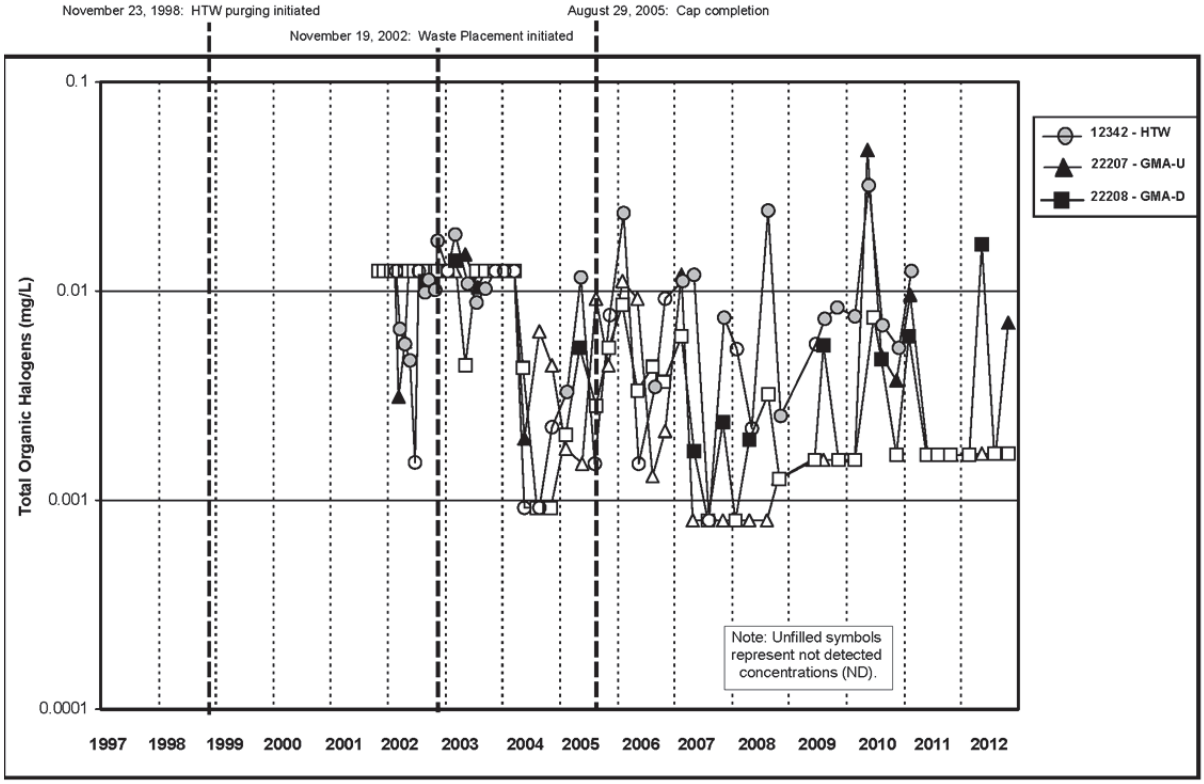


Figure A.5.5–14B. Cell 5 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

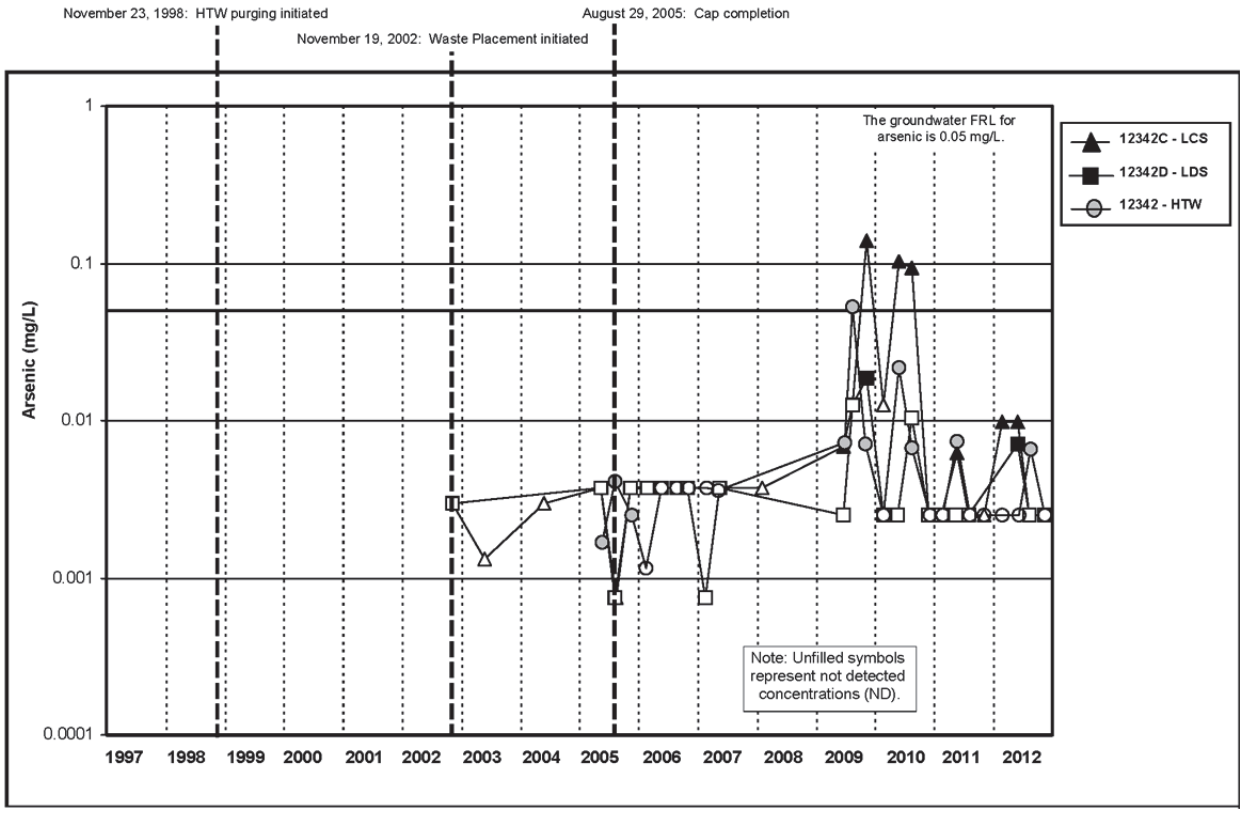


Figure A.5.5–15A. Cell 5 Arsenic Concentration vs. Time Plot for LCS, LDS, and HTW

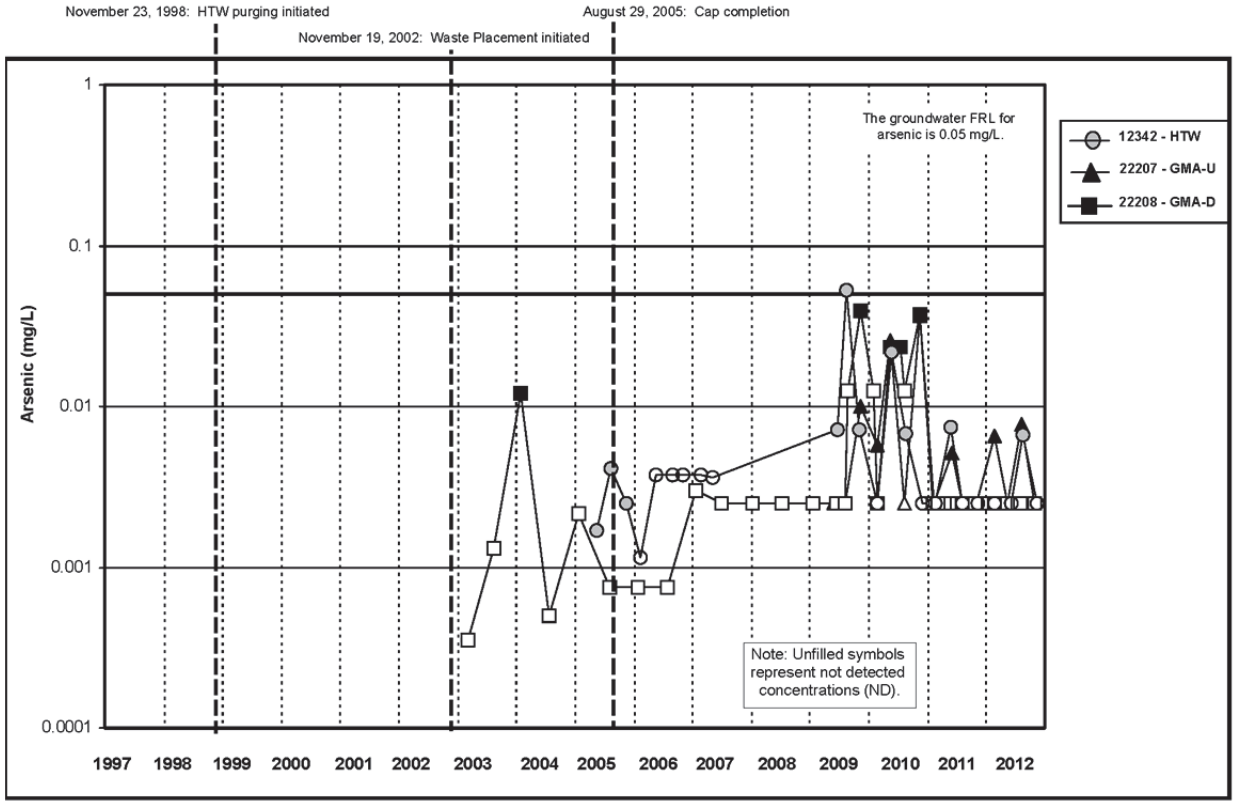


Figure A.5.5–15B. Cell 5 Arsenic Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

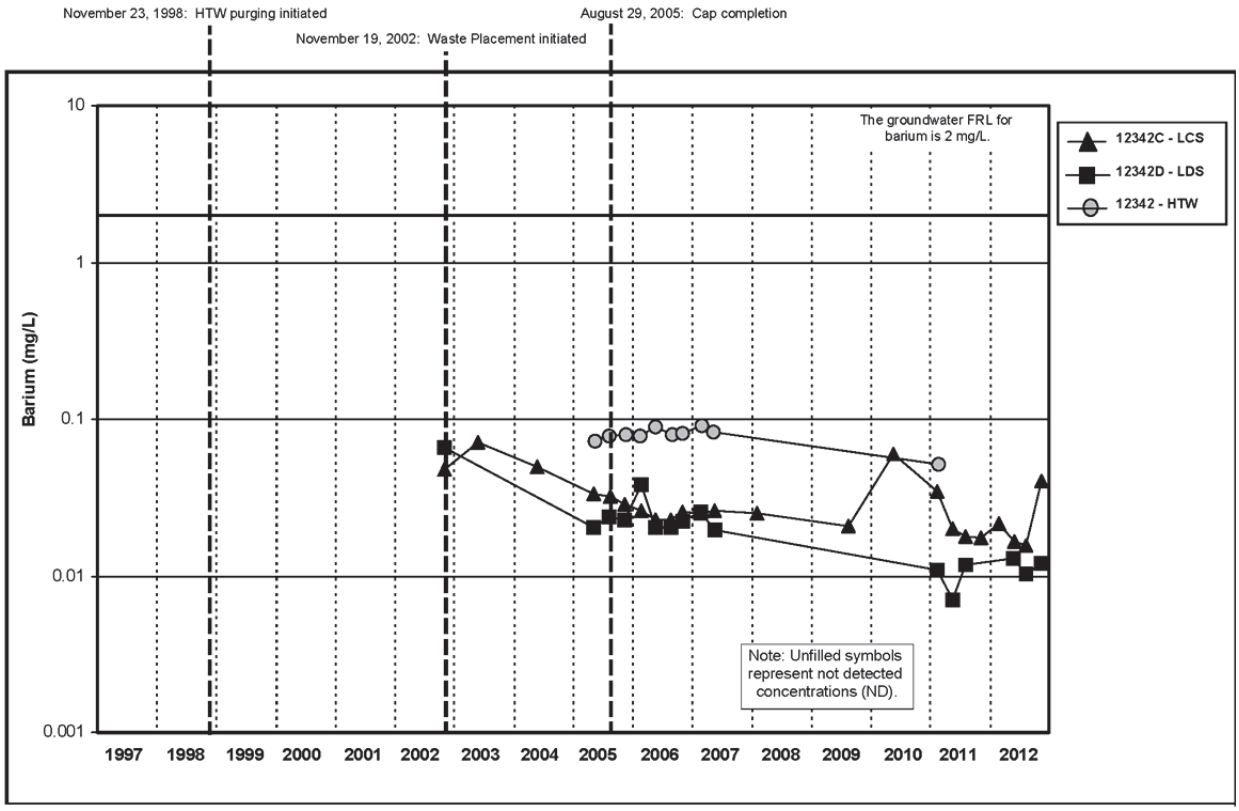


Figure A.5.5–16A. Cell 5 Barium Concentration vs. Time Plot for LCS, LDS, and HTW

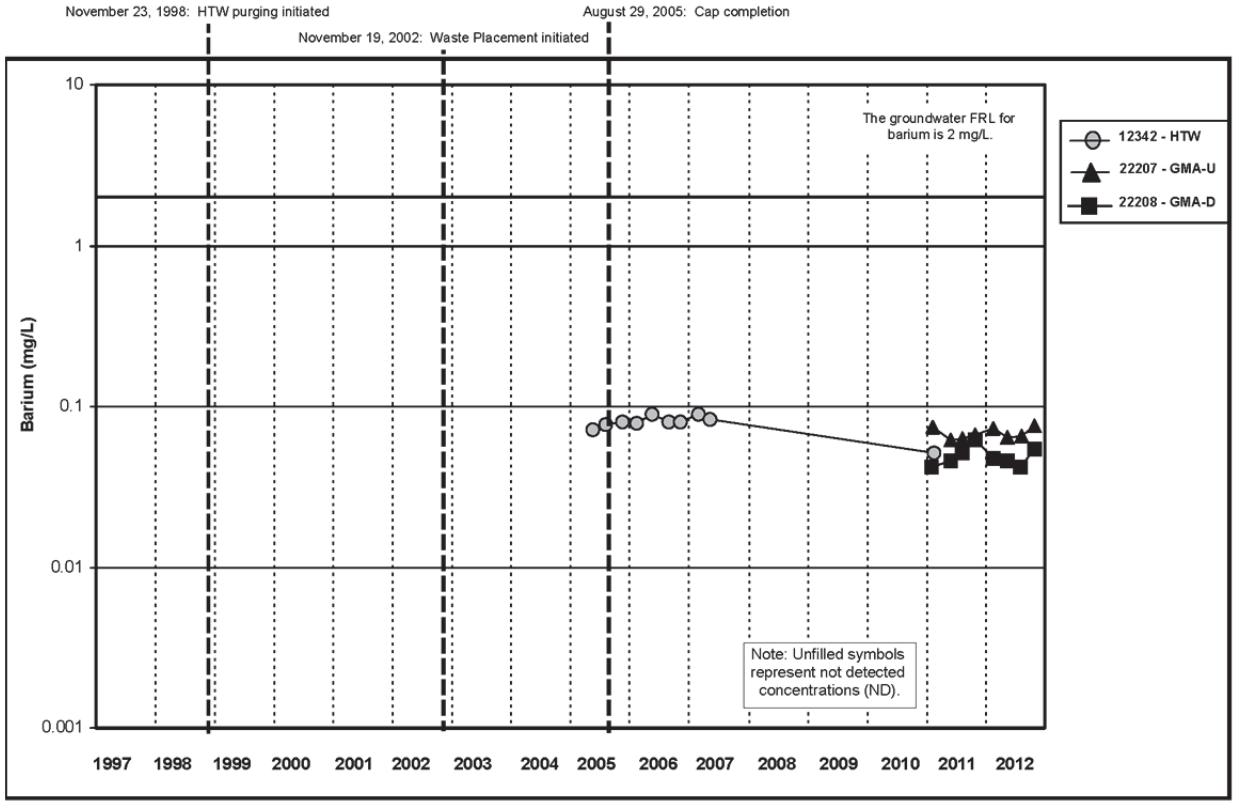


Figure A.5.5–16B. Cell 5 Barium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

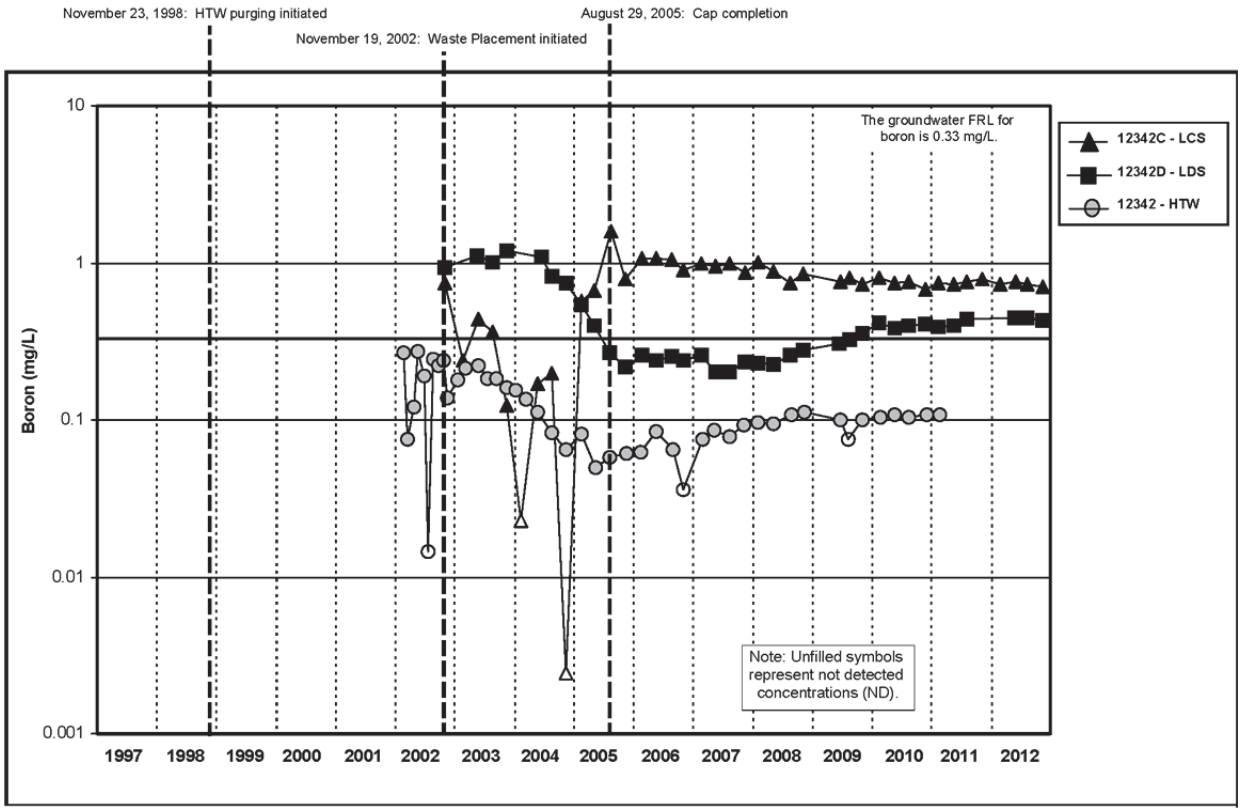


Figure A.5.5–17A. Cell 5 Boron Concentration vs. Time Plot for LCS, LDS, and HTW

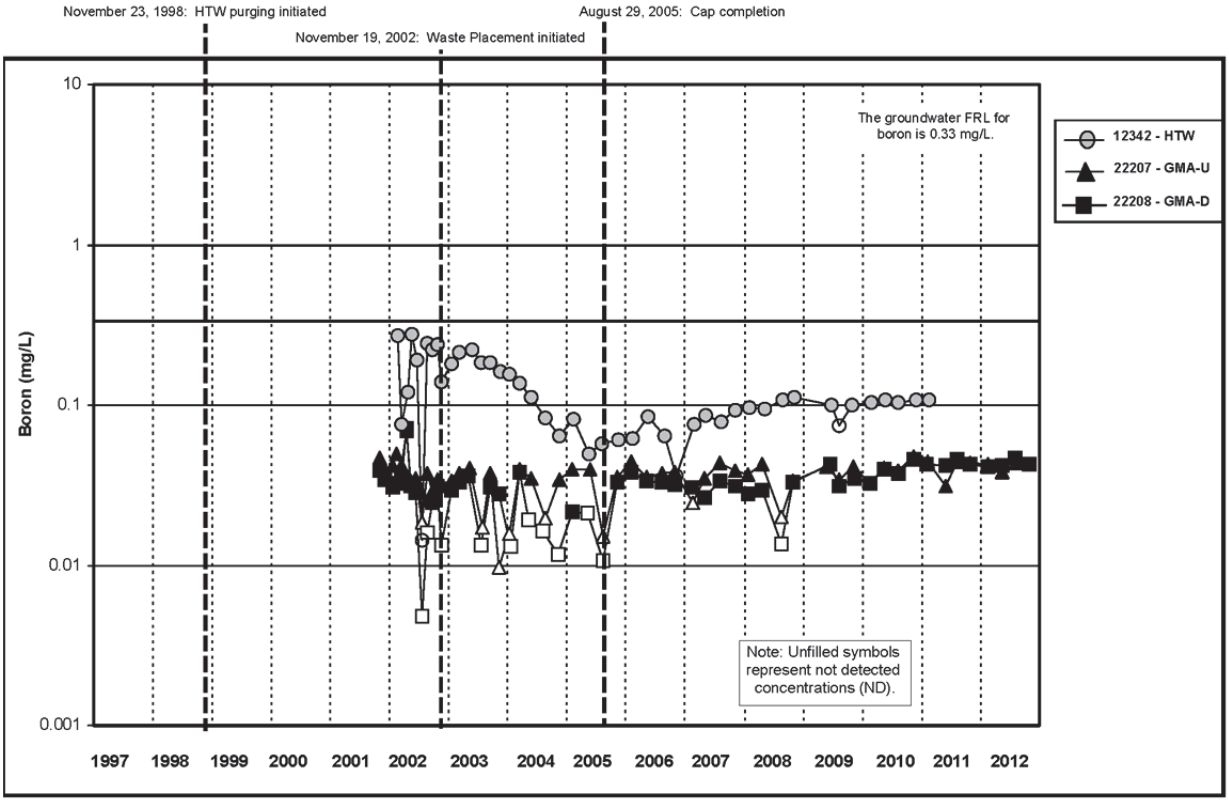


Figure A.5.5–17B. Cell 5 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

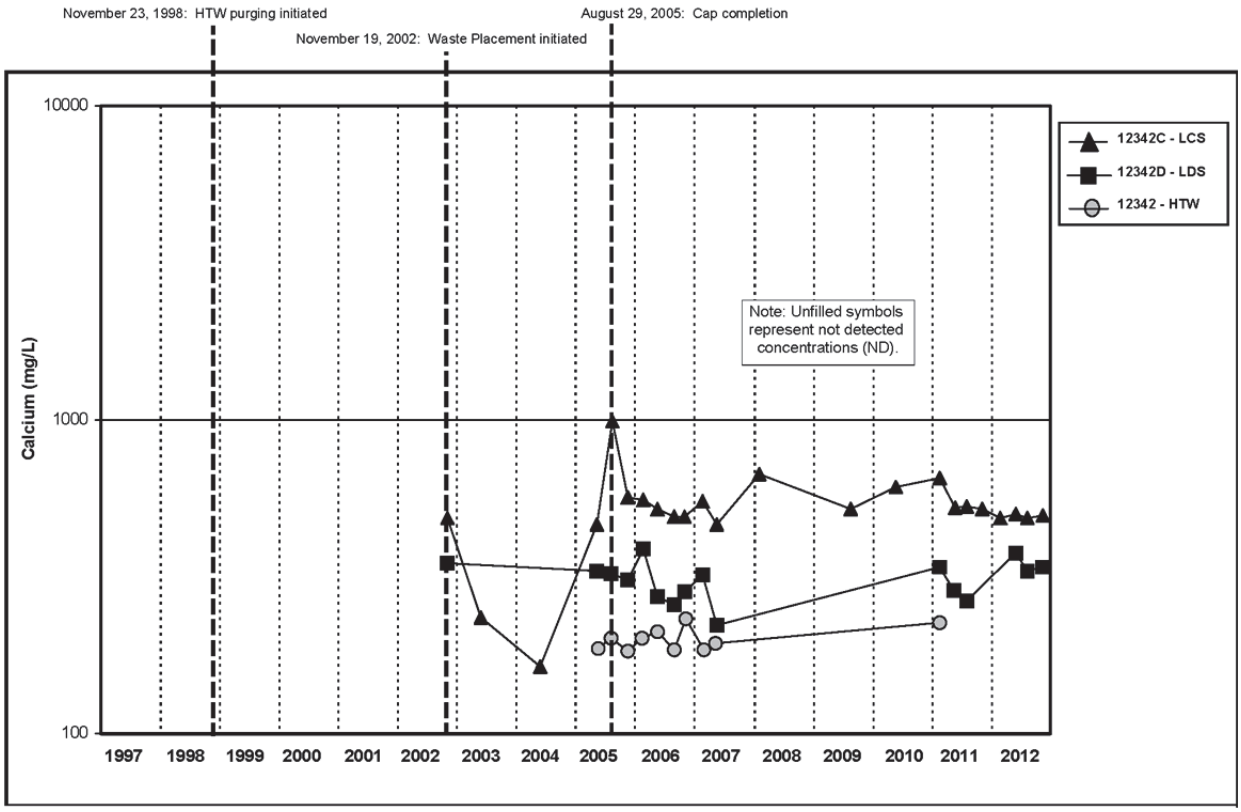


Figure A.5.5–18A. Cell 5 Calcium Concentration vs. Time Plot for LCS, LDS, and HTW

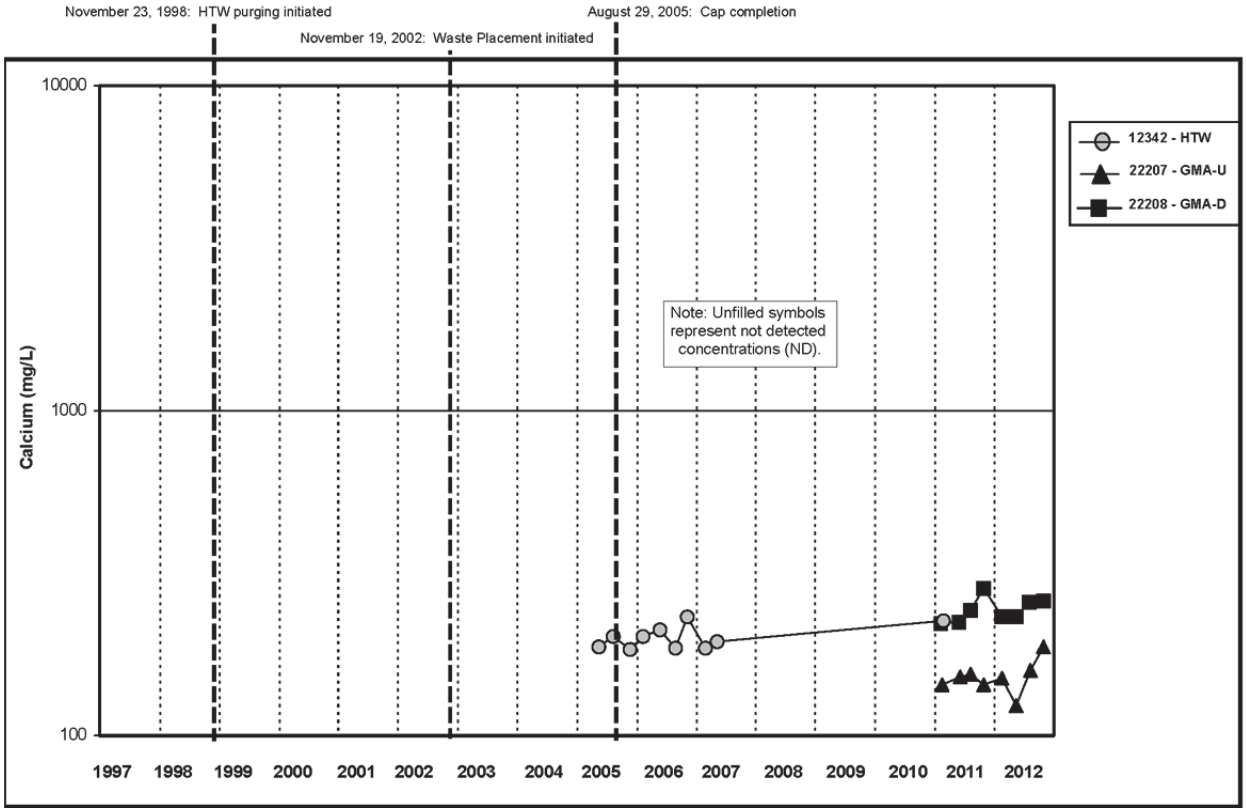


Figure A.5.5–18B. Cell 5 Calcium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

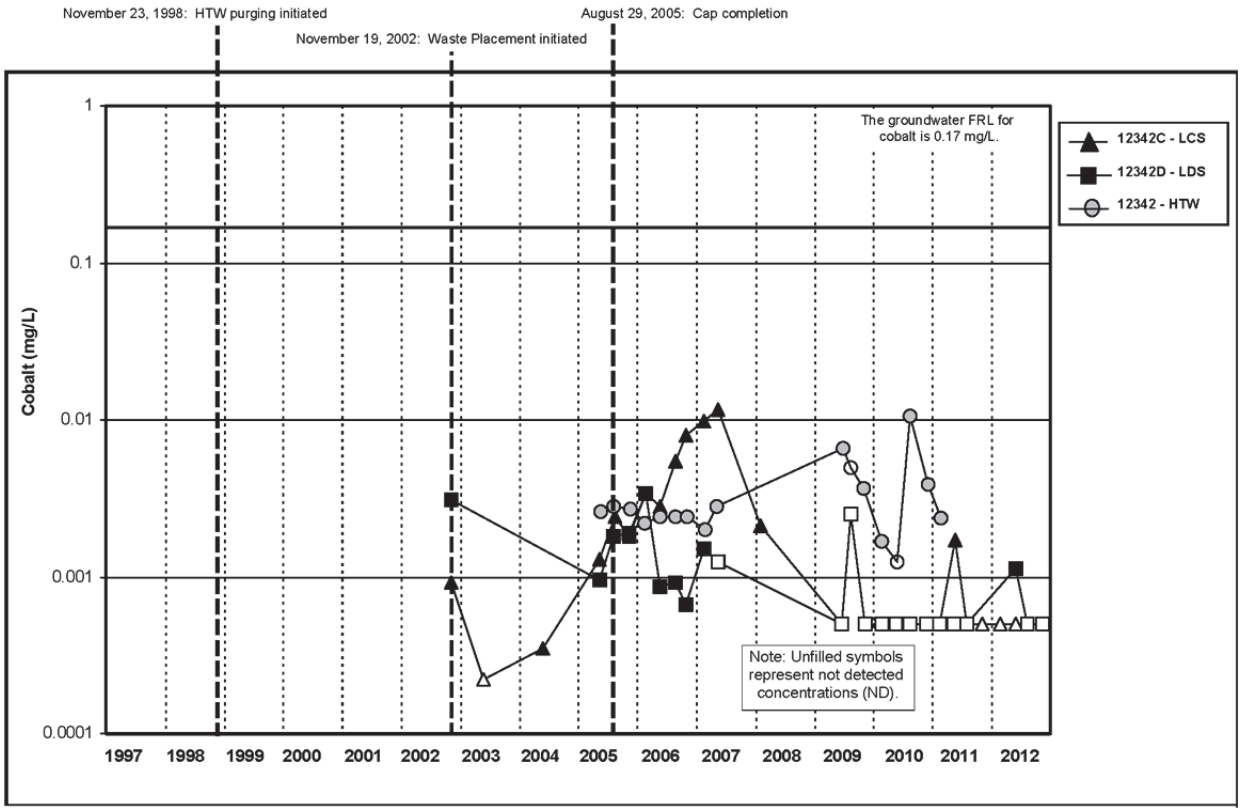


Figure A.5.5–19A. Cell 5 Cobalt Concentration vs. Time Plot for LCS, LDS, and HTW

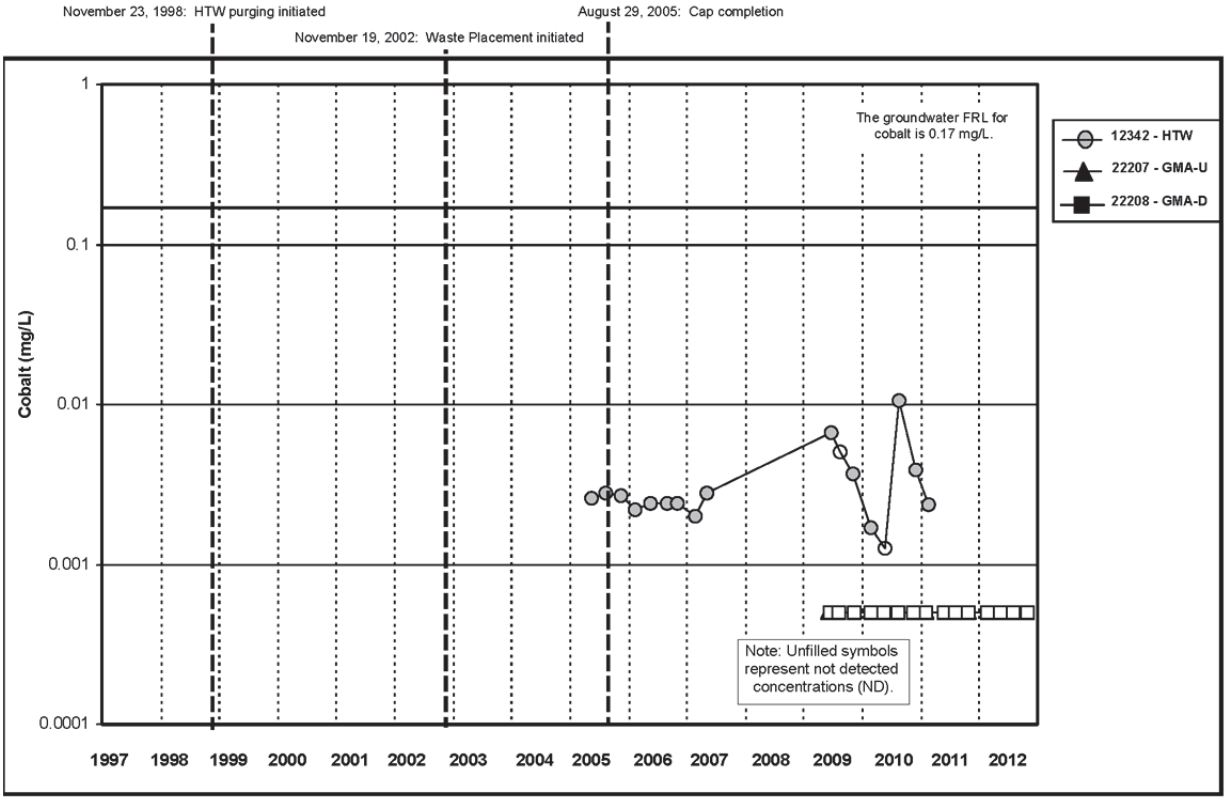


Figure A.5.5–19B. Cell 5 Cobalt Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

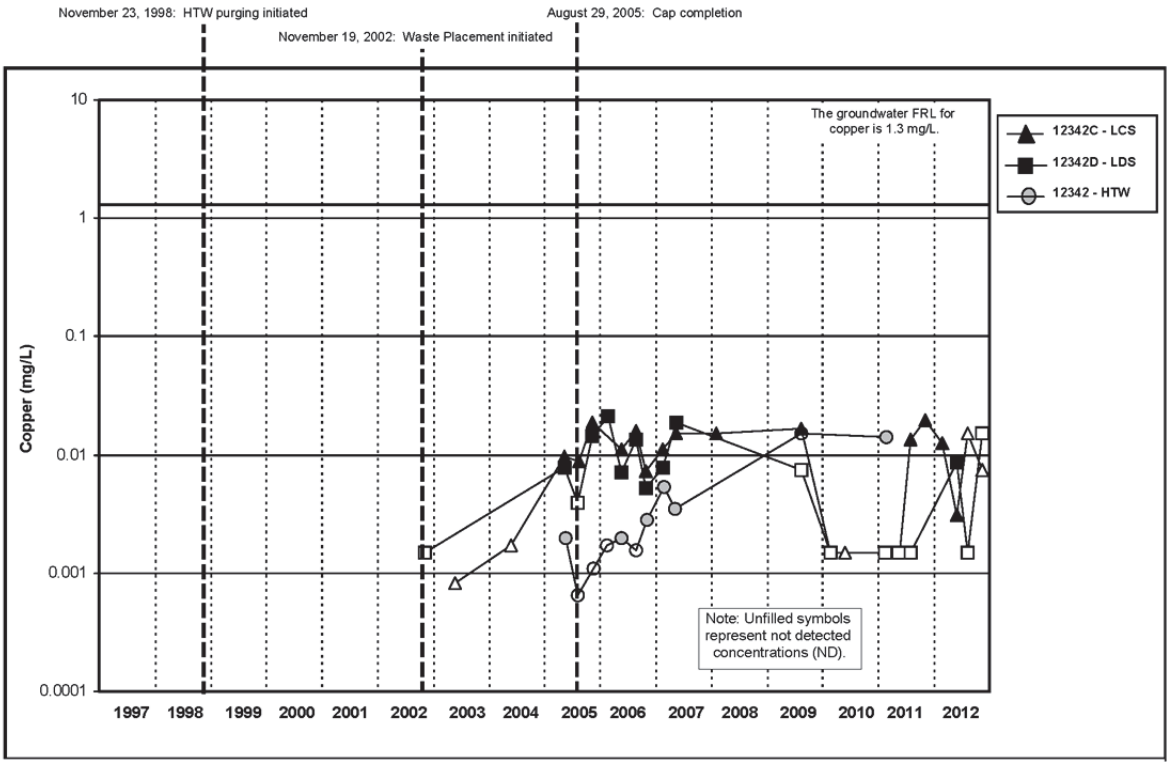


Figure A.5.5–20A. Cell 5 Copper Concentration vs. Time Plot for LCS, LDS, and HTW

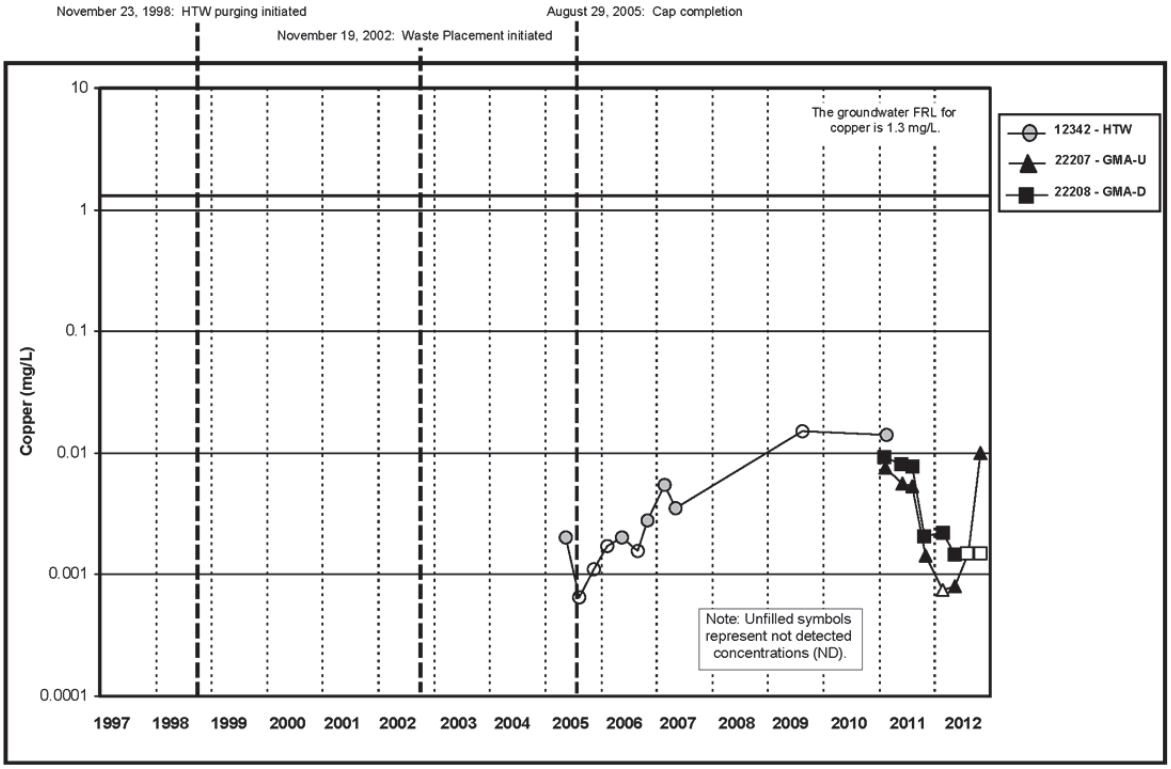


Figure A.5.5–20B. Cell 5 Copper Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

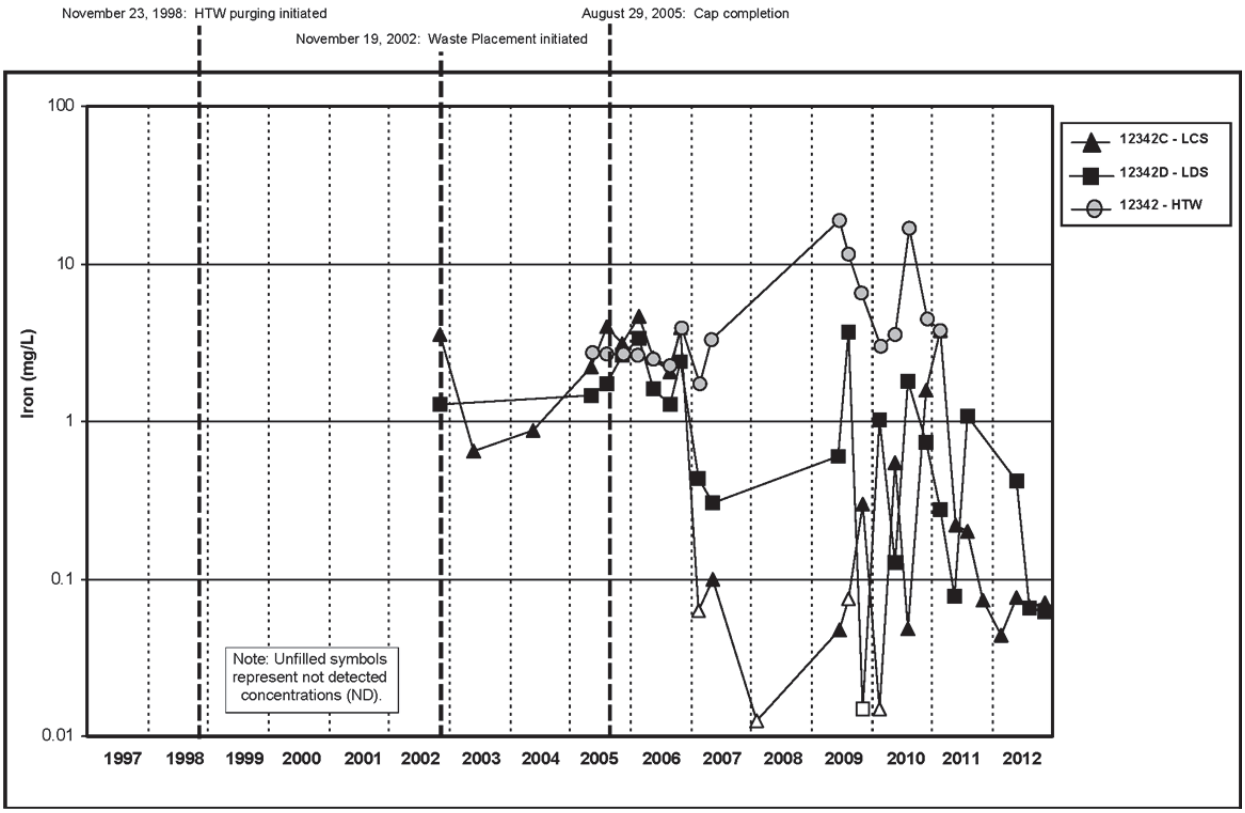


Figure A.5.5–21A. Cell 5 Iron Concentration vs. Time Plot for LCS, LDS, and HTW

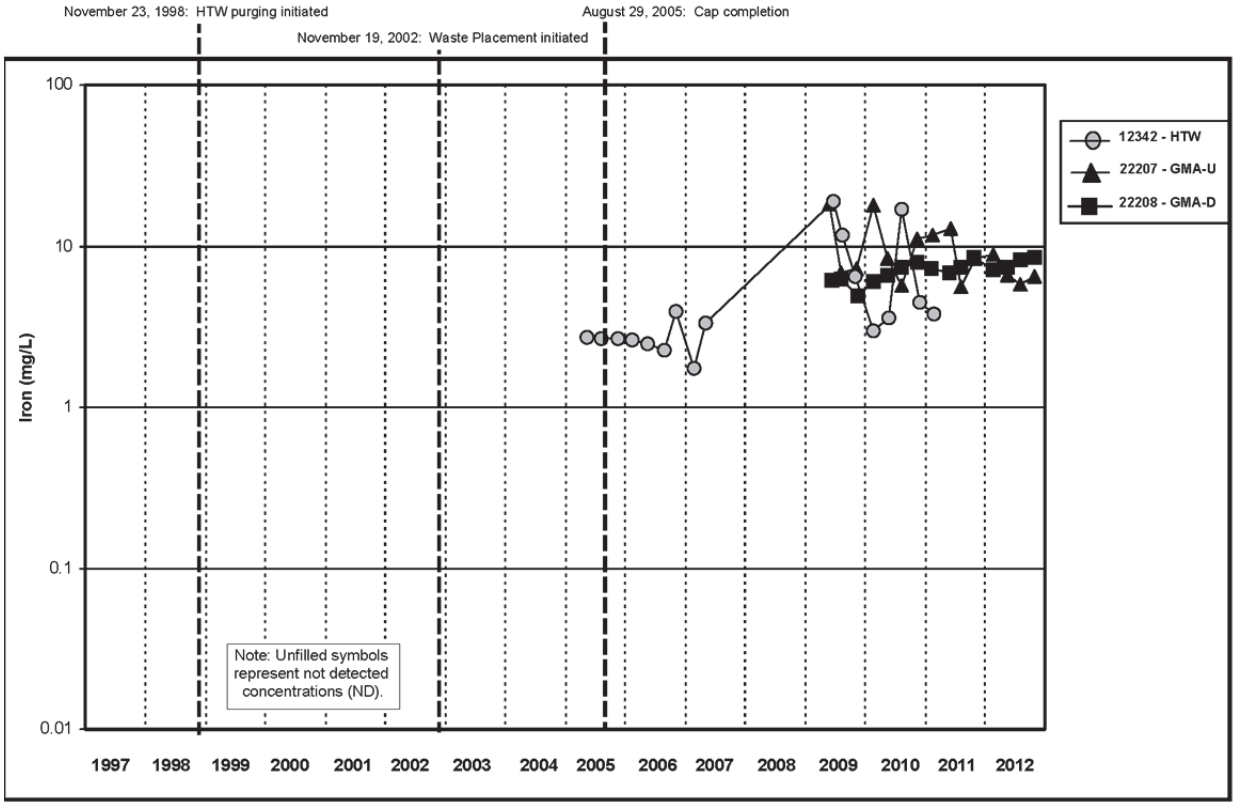


Figure A.5.5–21B. Cell 5 Iron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

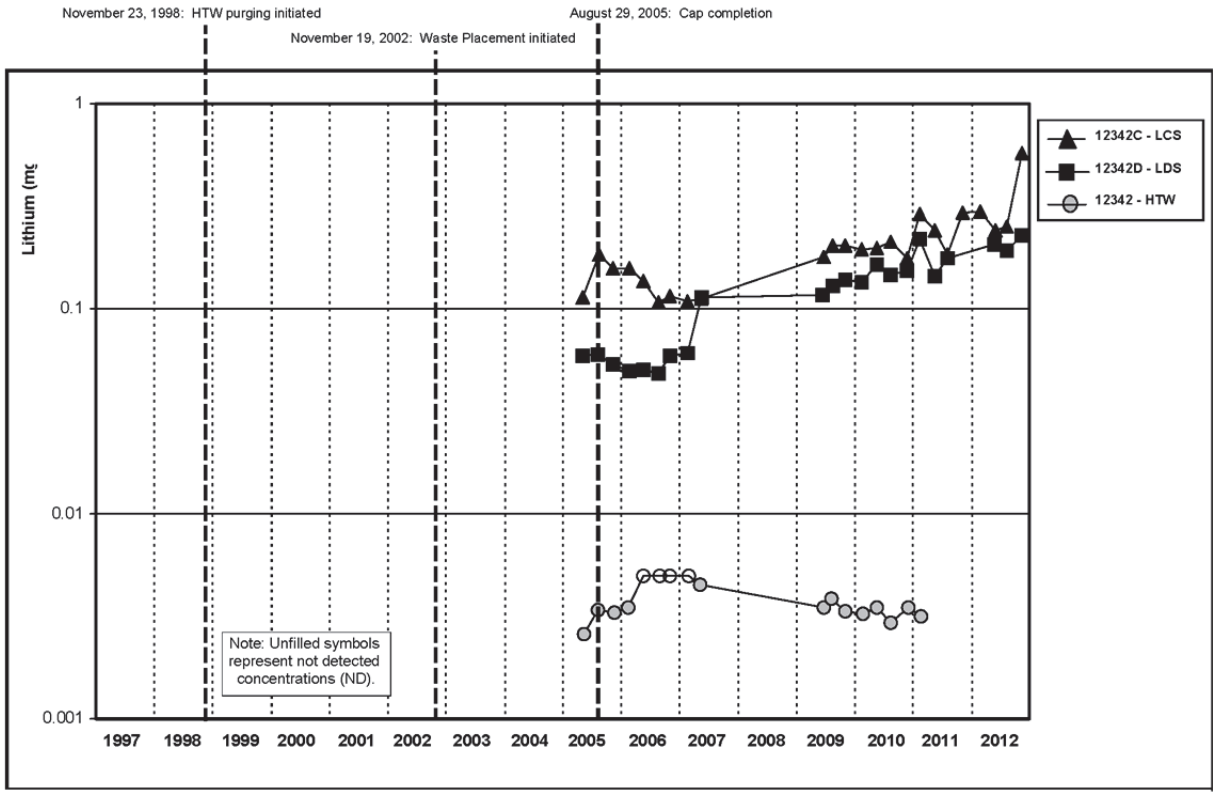


Figure A.5.5–22A. Cell 5 Lithium Concentration vs. Time Plot for LCS, LDS, and HTW

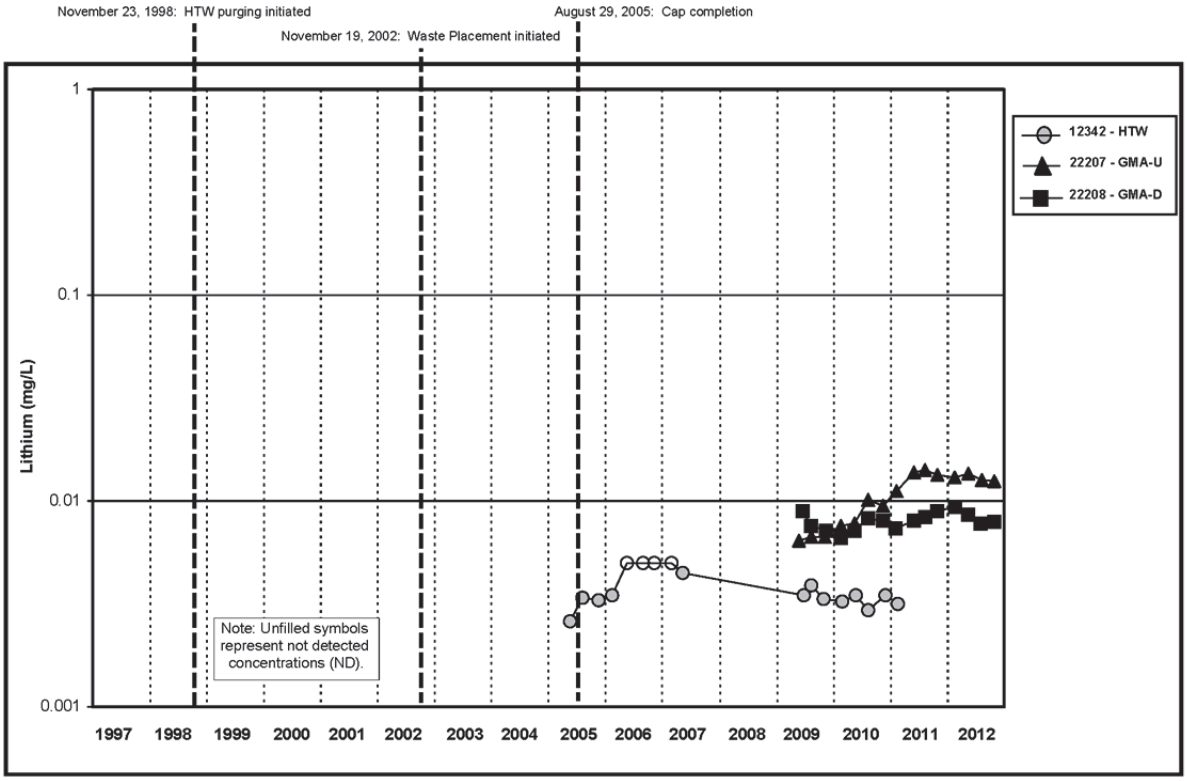


Figure A.5.5–22B. Cell 5 Lithium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

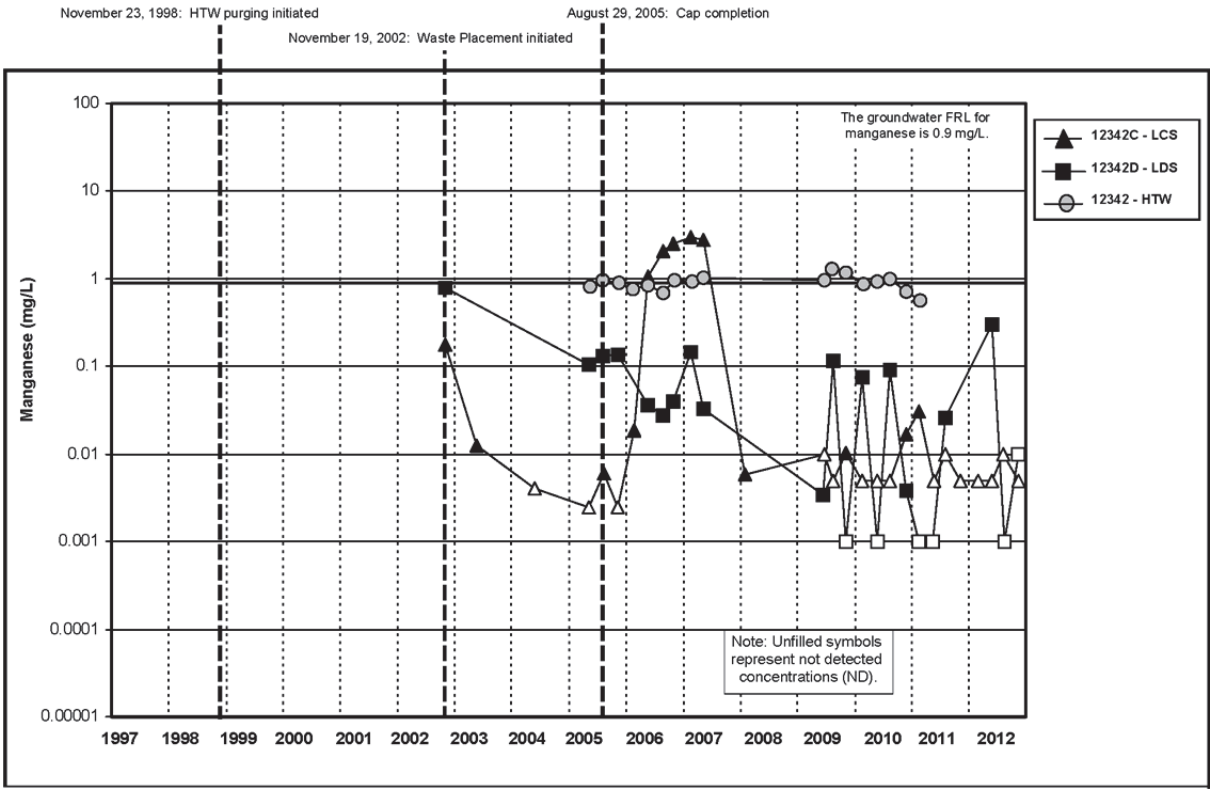


Figure A.5.5–23A. Cell 5 Manganese Concentration vs. Time Plot for LCS, LDS, and HTW

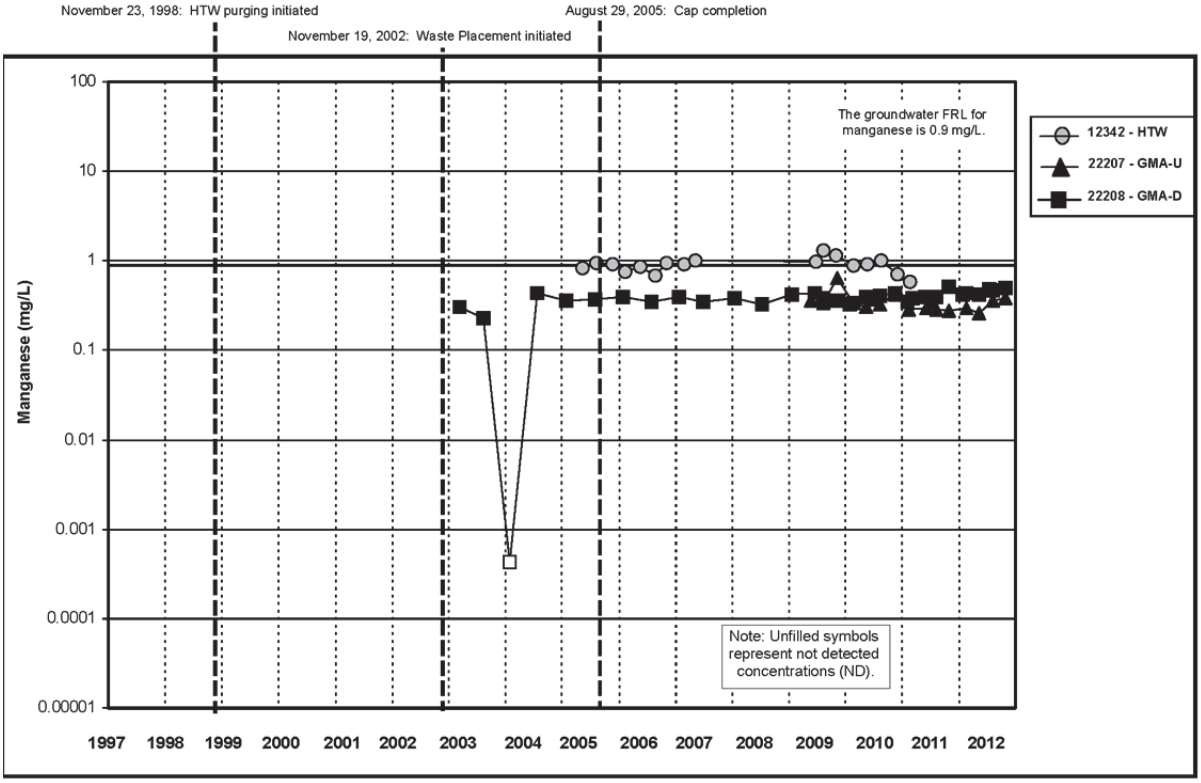


Figure A.5.5–23B. Cell 5 Manganese Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

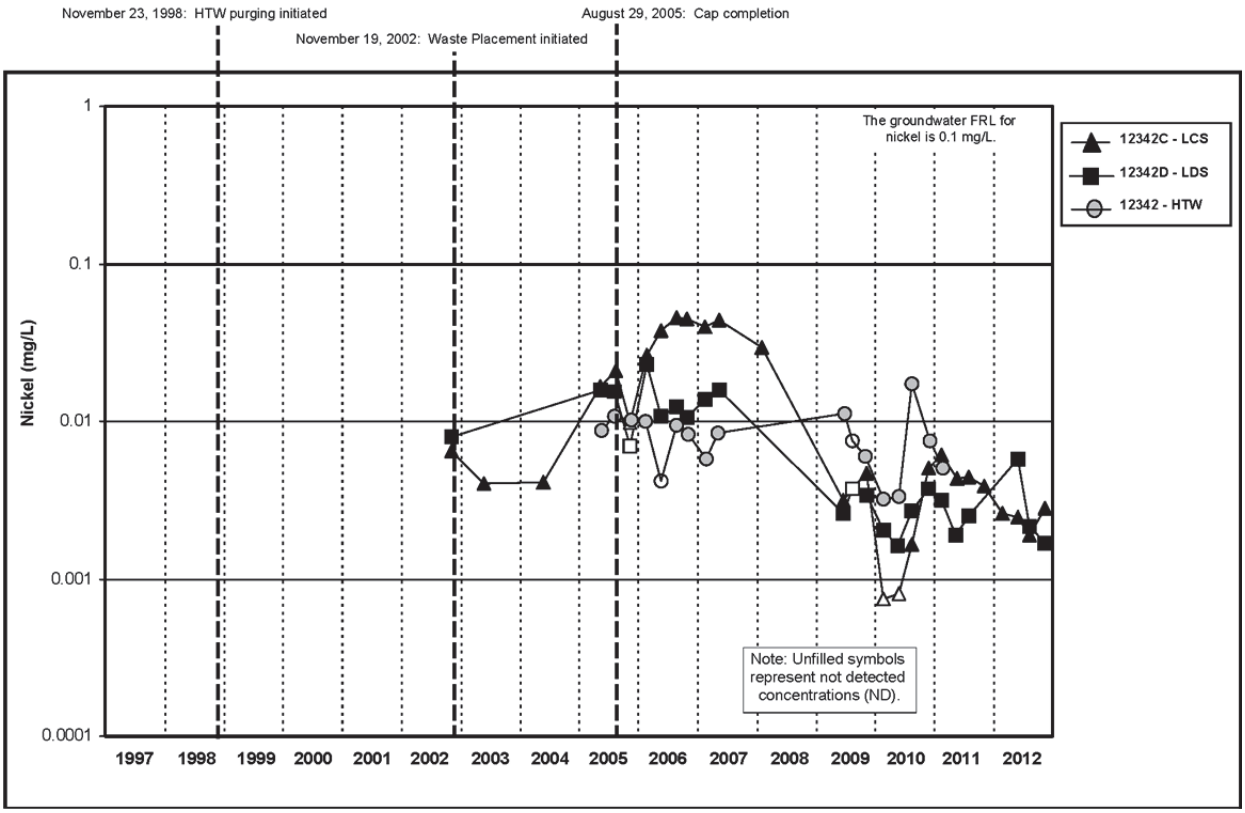


Figure A.5.5–24A. Cell 5 Nickel Concentration vs. Time Plot for LCS, LDS, and HTW

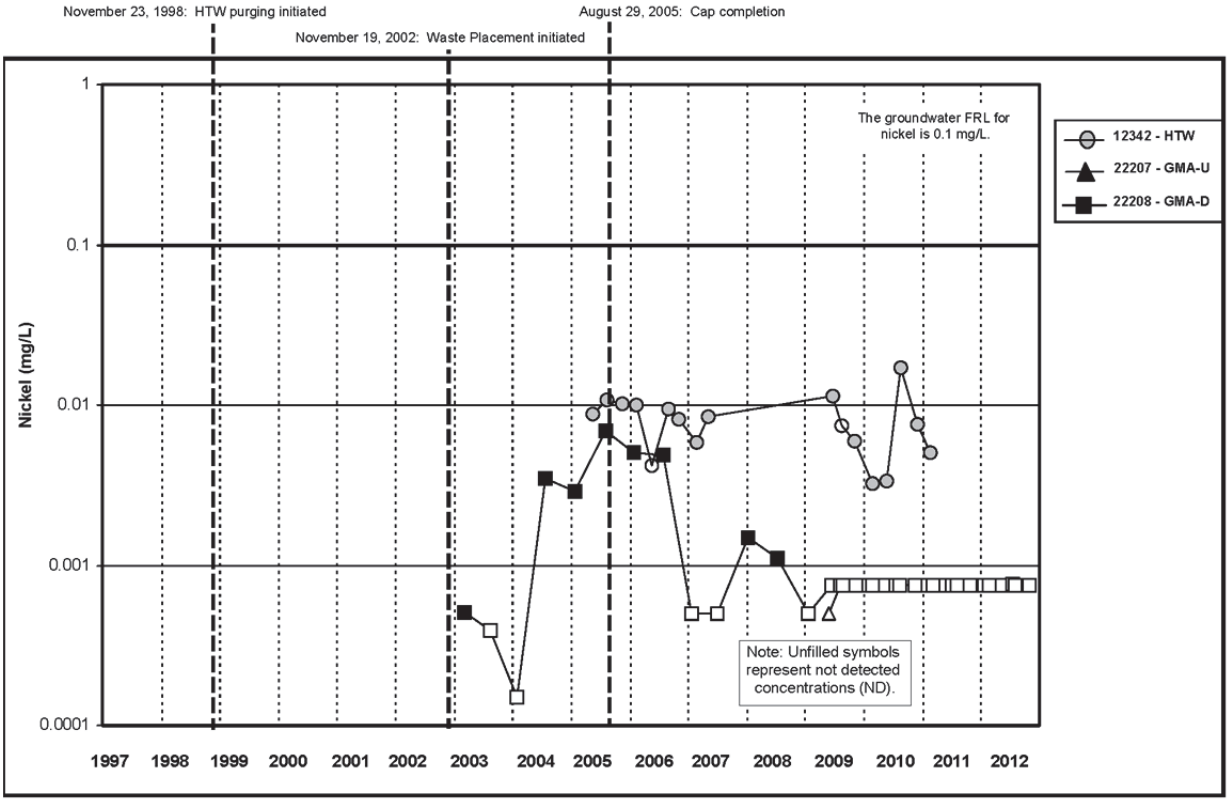


Figure A.5.5–24B. Cell 5 Nickel Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

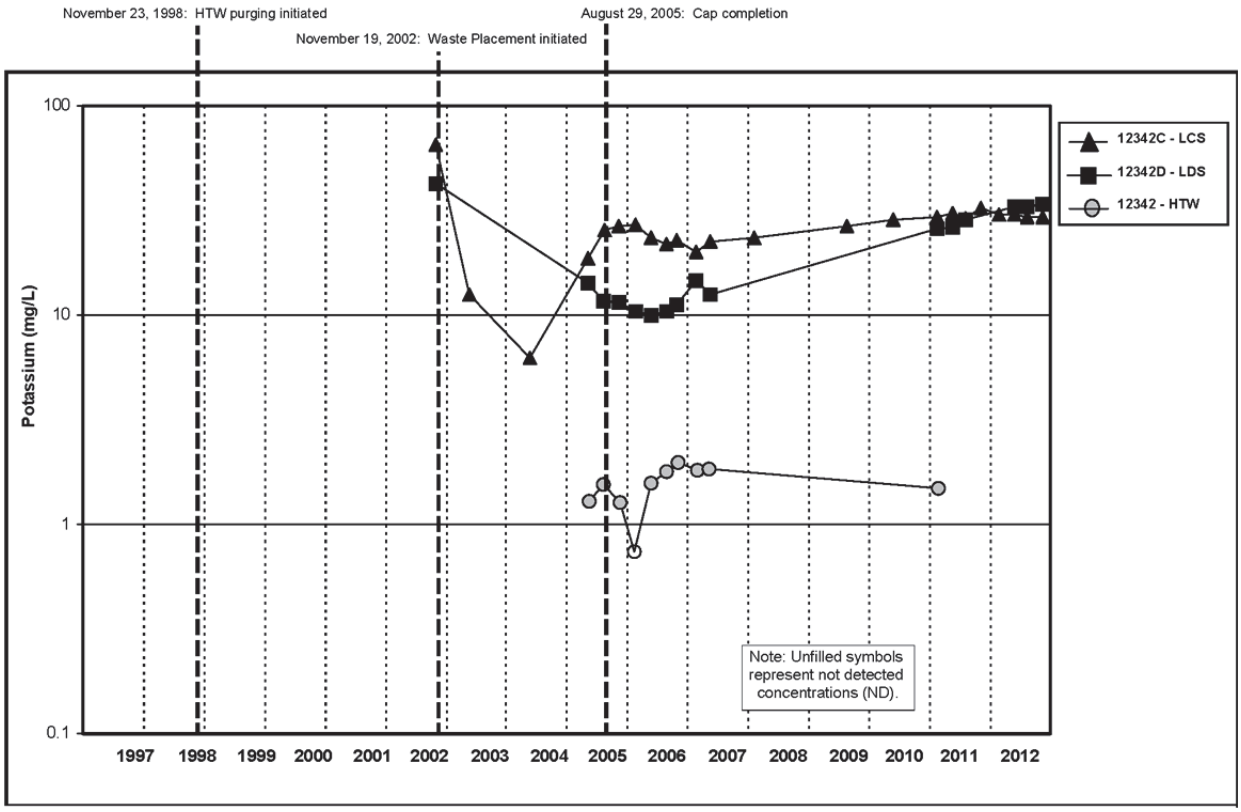


Figure A.5.5–25A. Cell 5 Potassium Concentration vs. Time Plot for LCS, LDS, and HTW

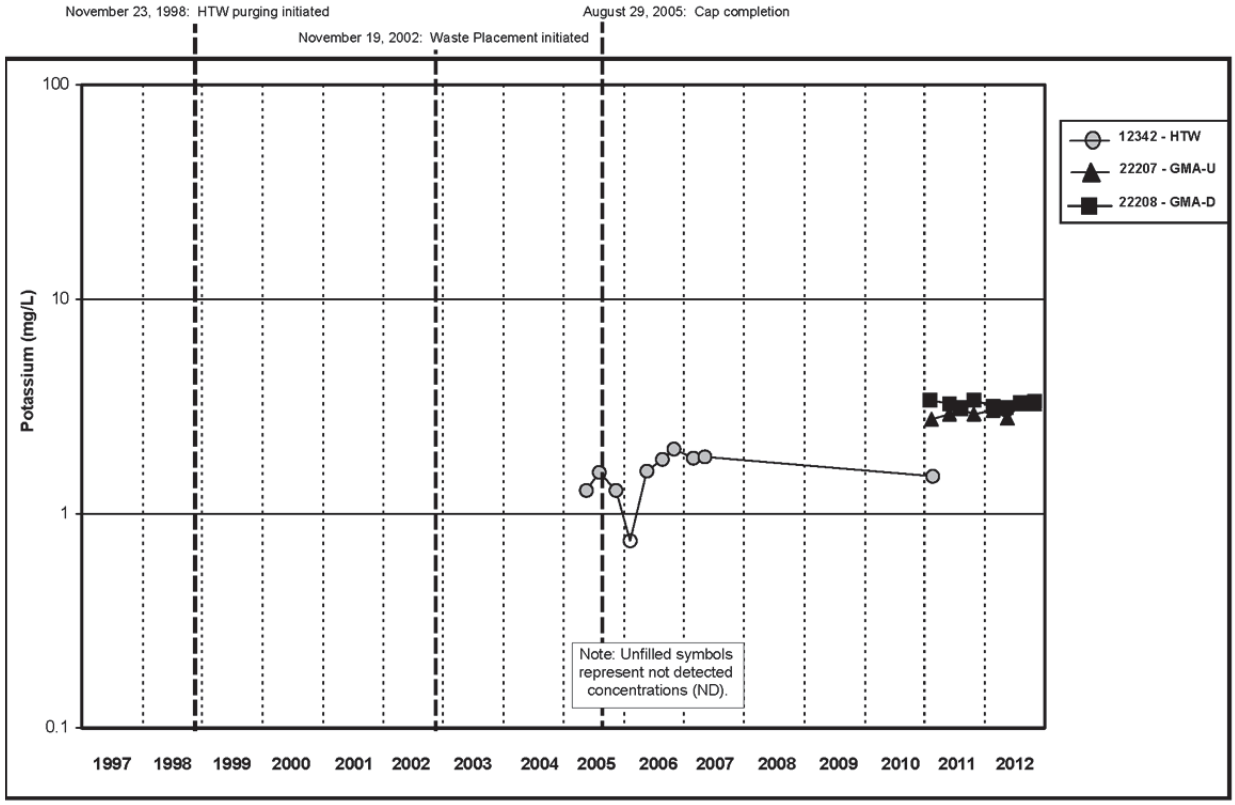


Figure A.5.5–25B. Cell 5 Potassium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

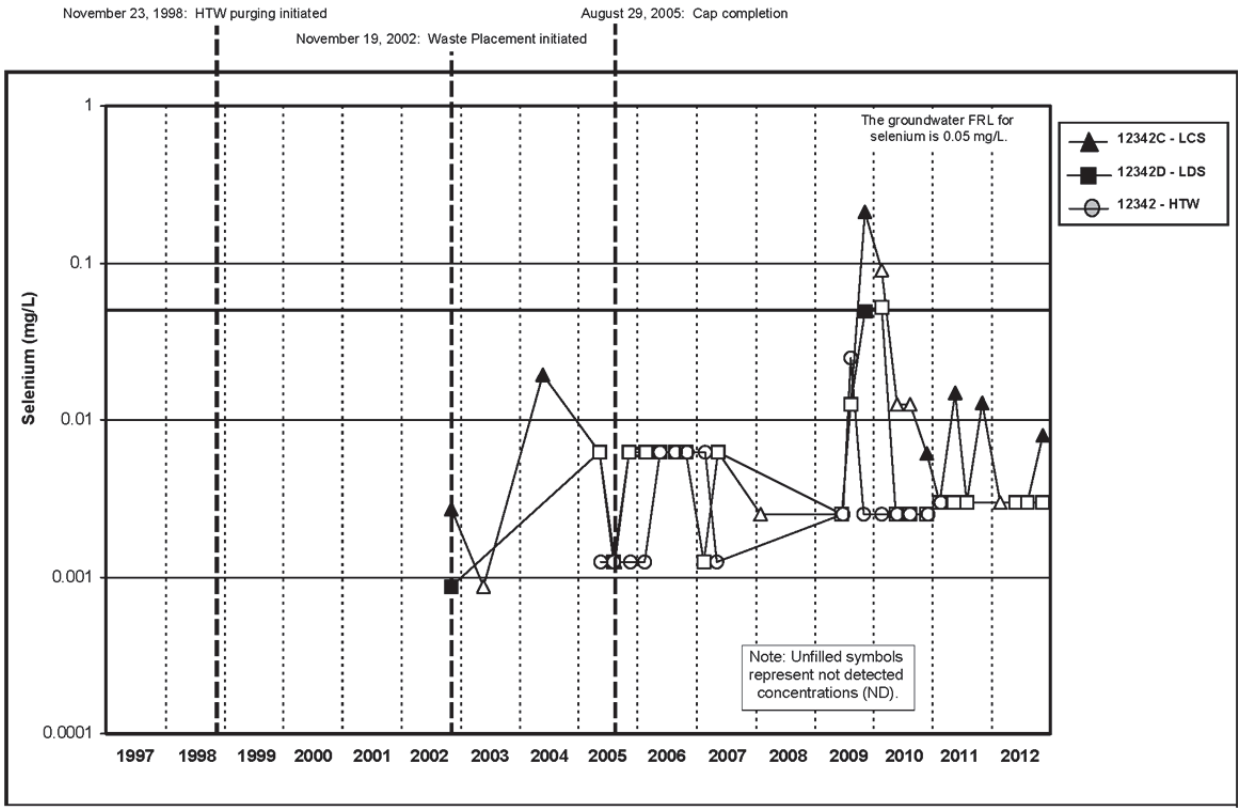


Figure A.5.5–26A. Cell 5 Selenium Concentration vs. Time Plot for LCS, LDS, and HTW

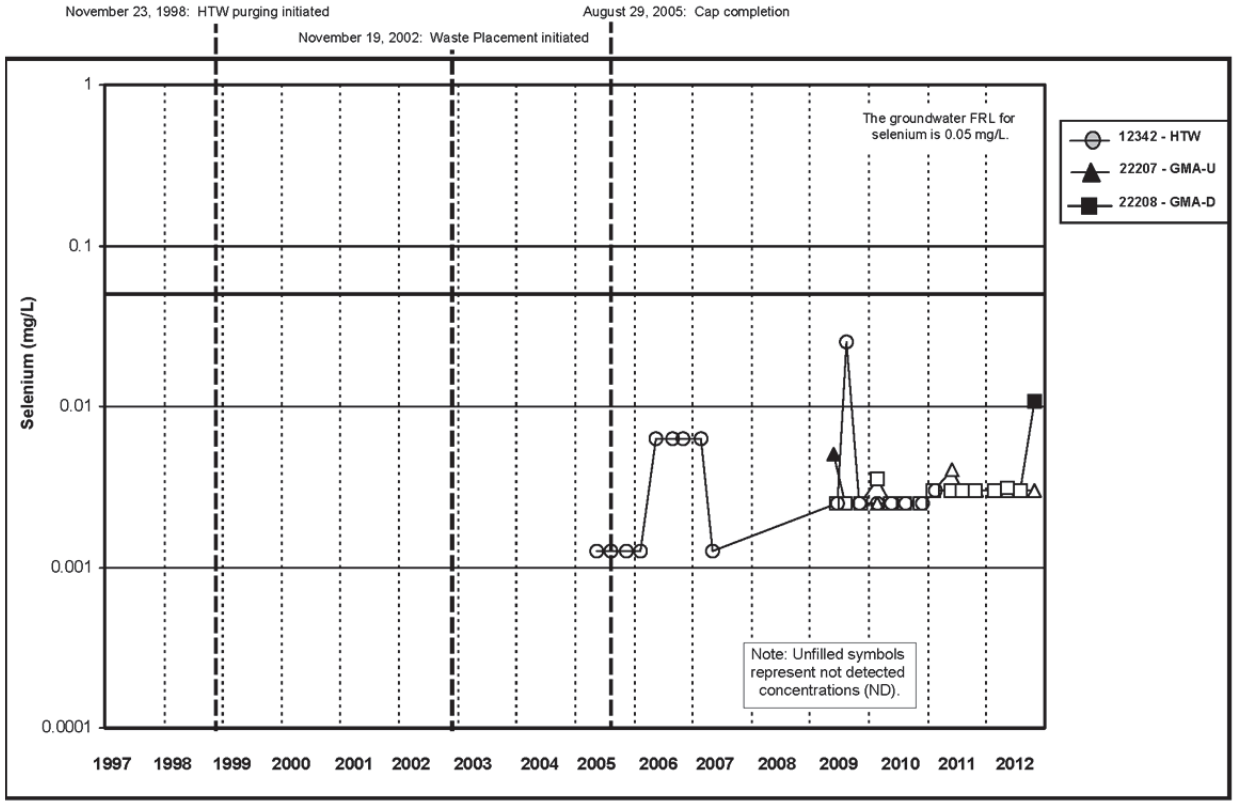


Figure A.5.5–26B. Cell 5 Selenium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

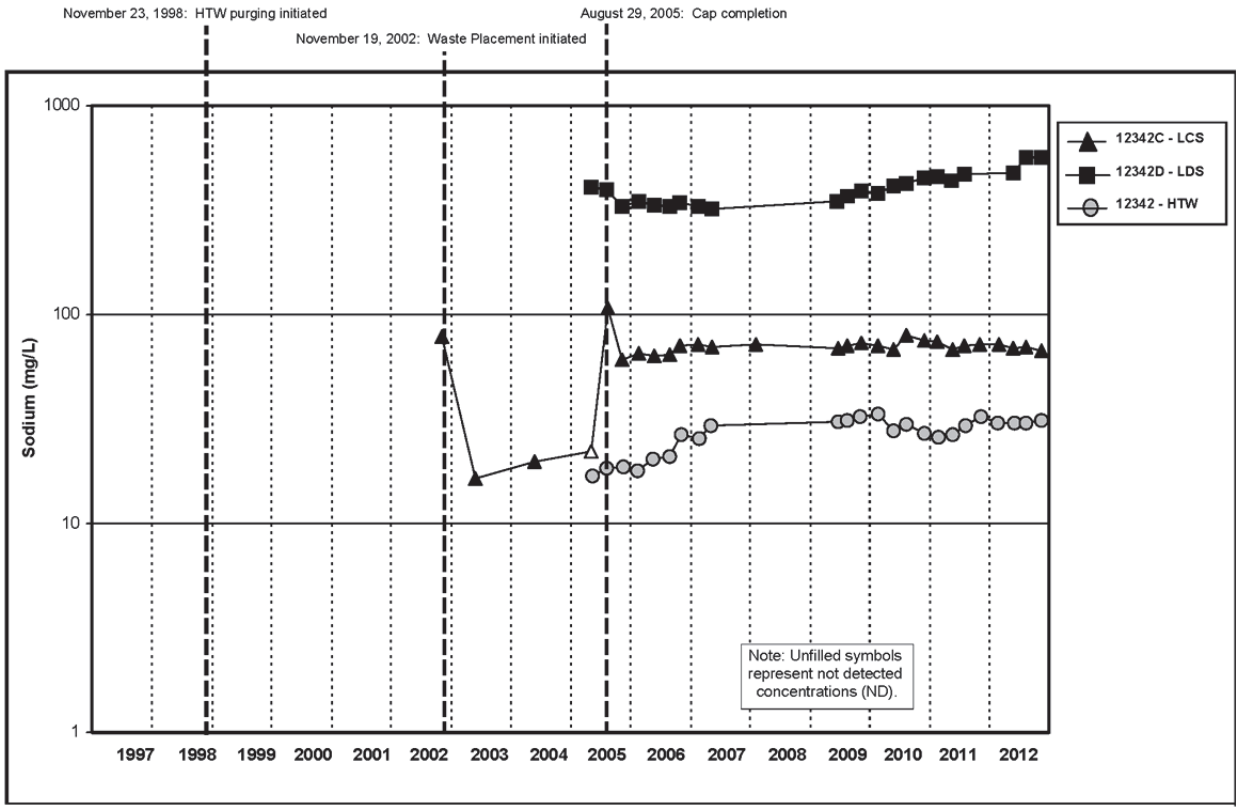


Figure A.5.5–27A. Cell 5 Sodium Concentration vs. Time Plot for LCS, LDS, and HTW

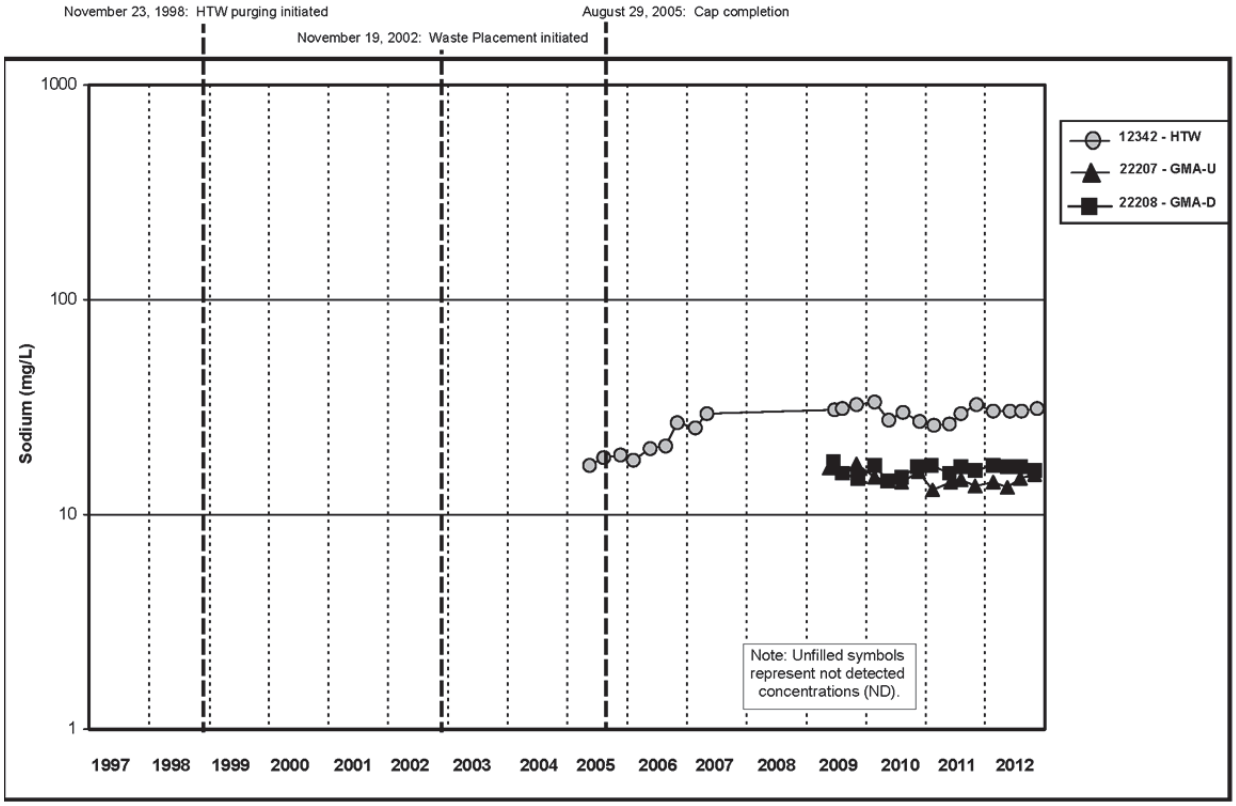


Figure A.5.5–27B. Cell 5 Sodium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

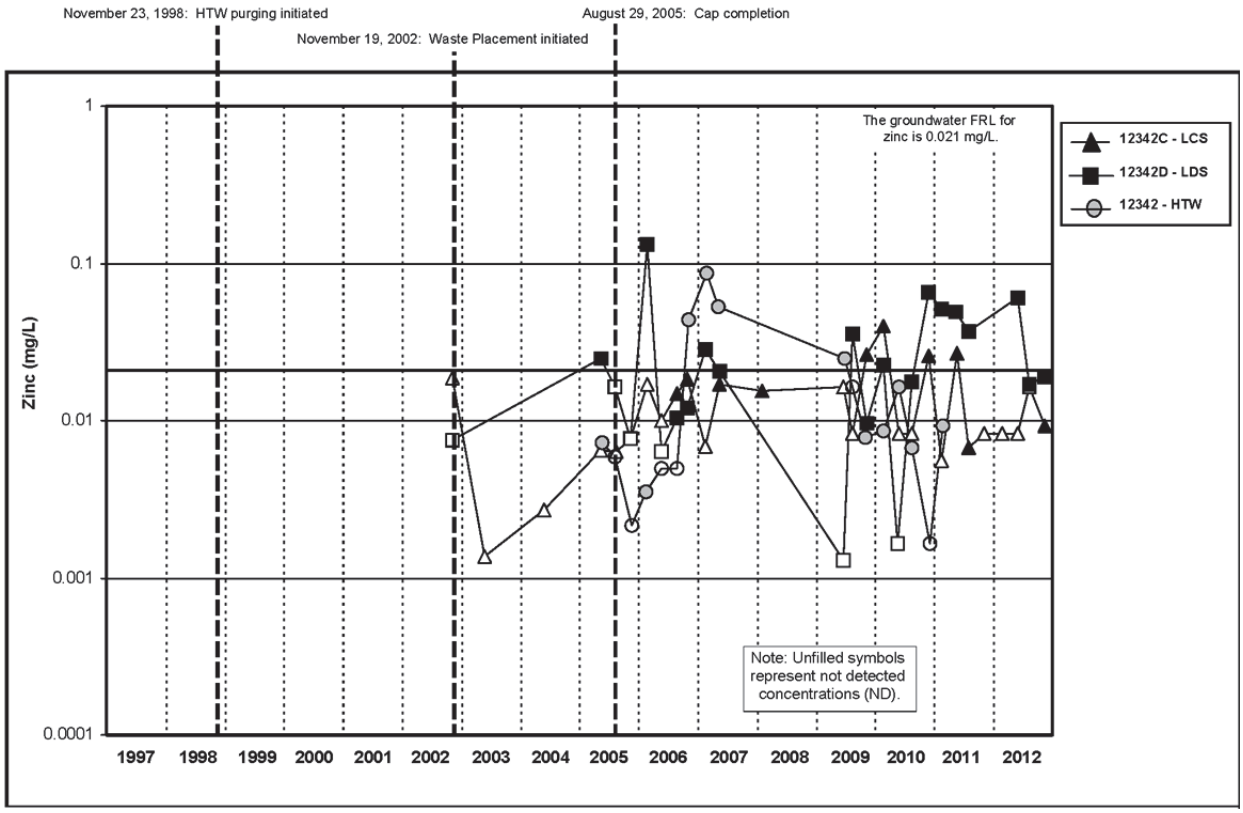


Figure A.5.5–28A. Cell 5 Zinc Concentration vs. Time Plot for LCS, LDS, and HTW

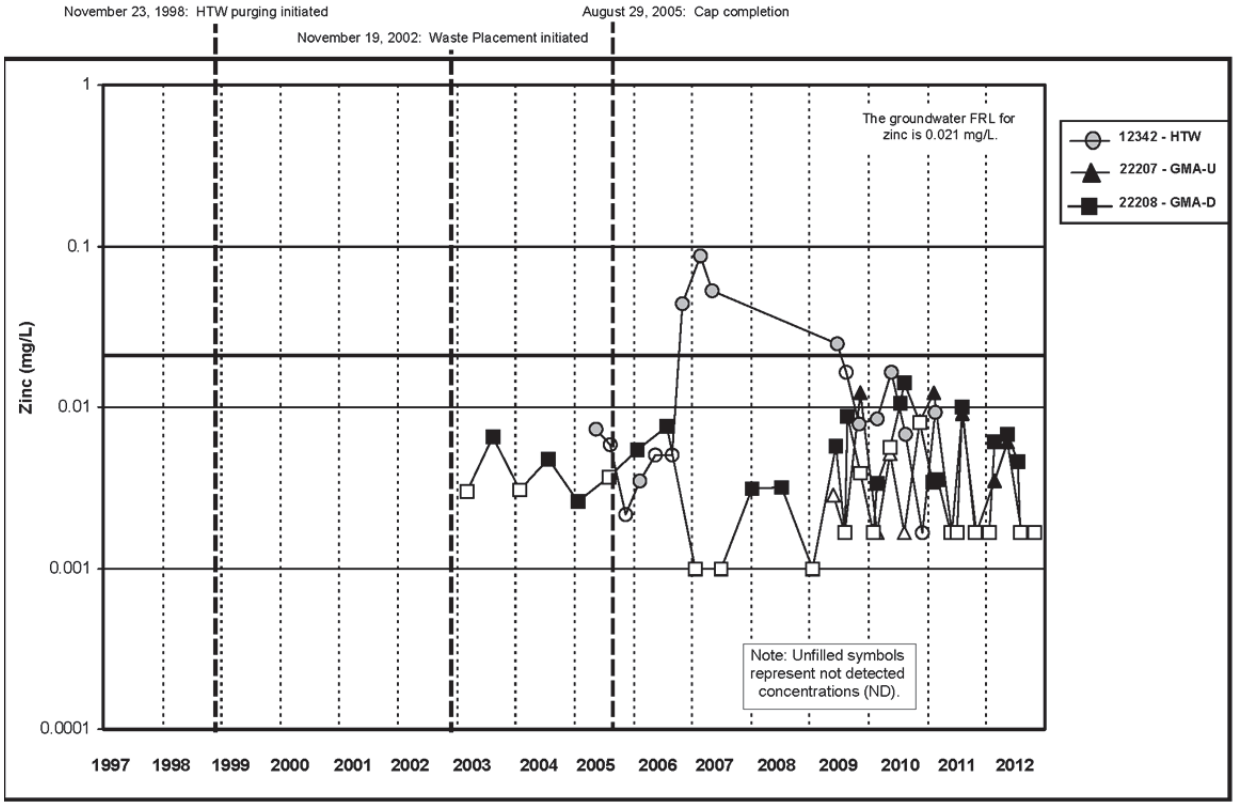


Figure A.5.5–28B. Cell 5 Zinc Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

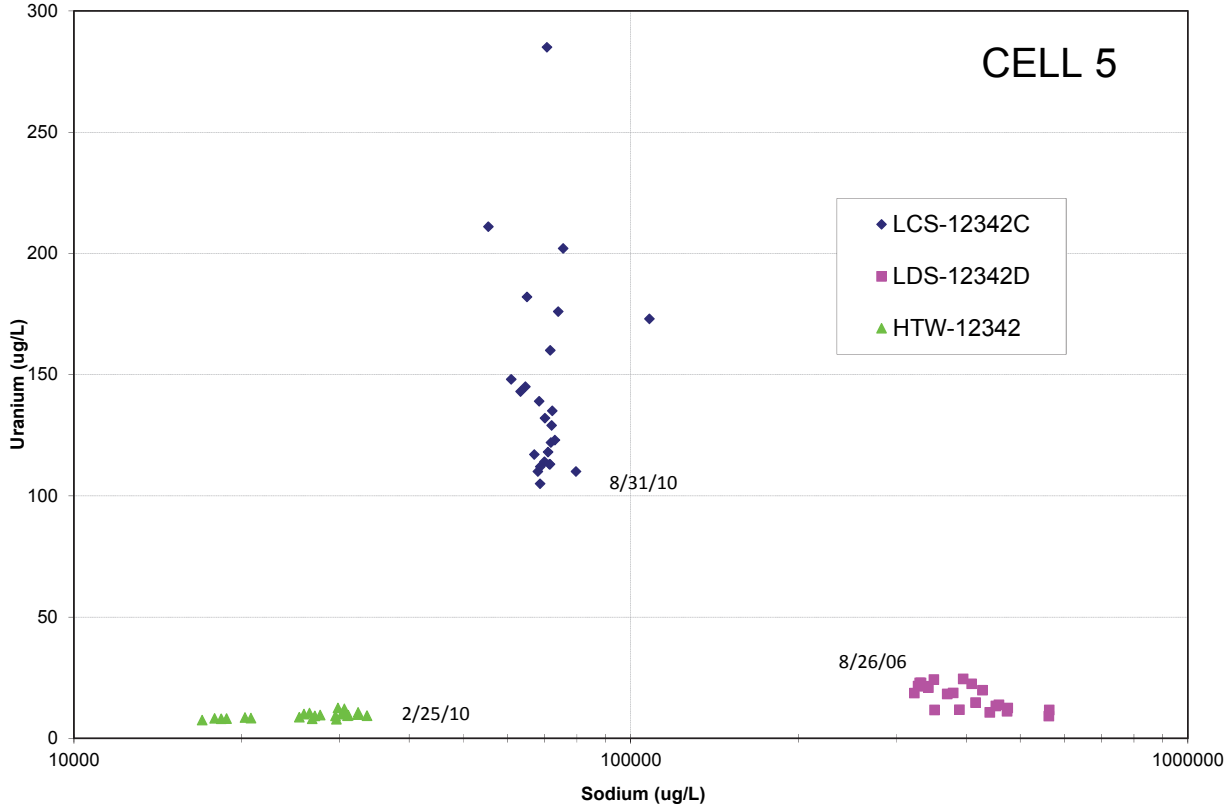


Figure A.5.5–29. Cell 5 Bivariate Plot for Uranium and Sodium

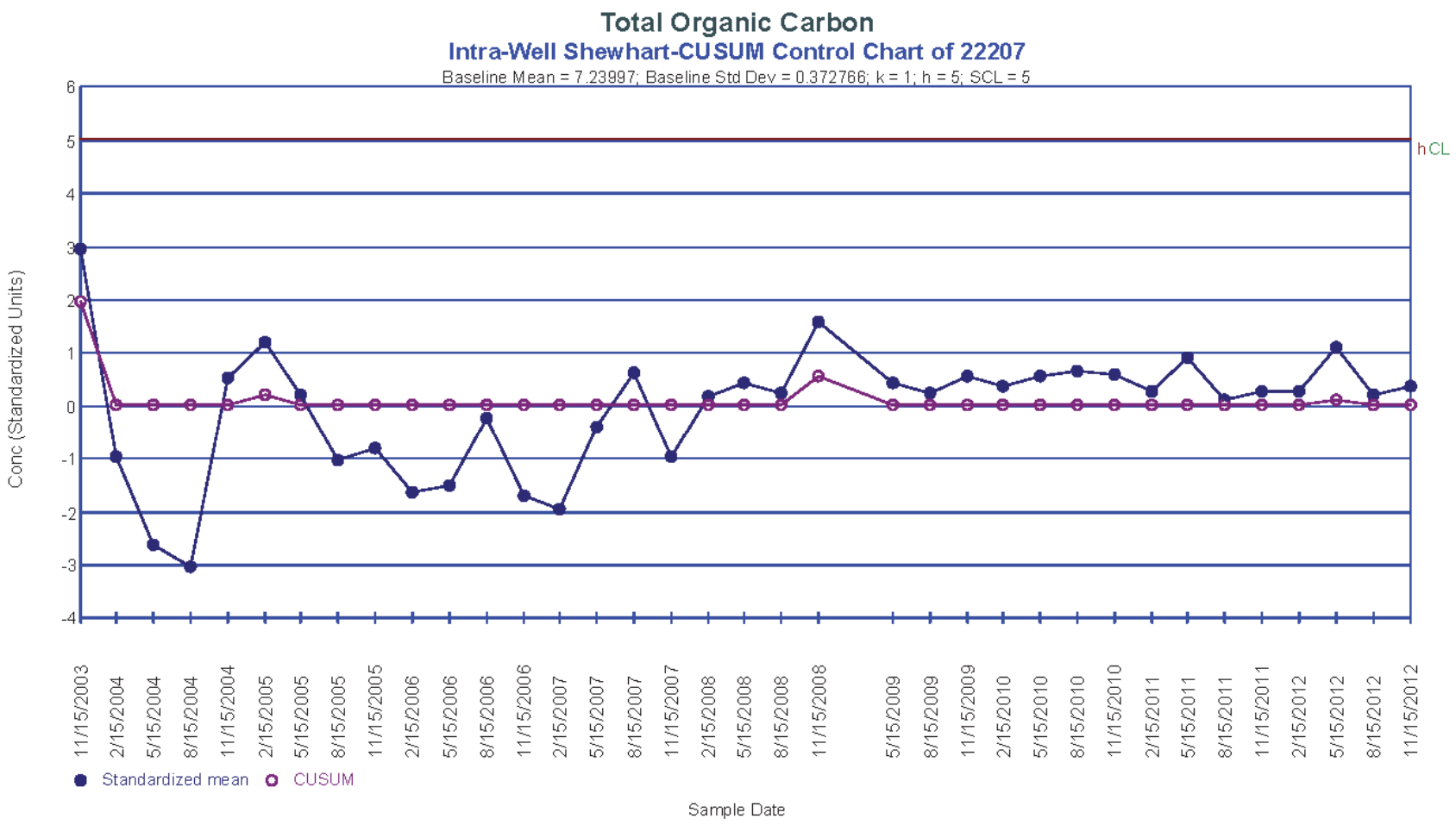


Figure A.5.5–30. Intra-Well Shewhart-CUSUM Control Chart (Total Organic Carbon 22207)

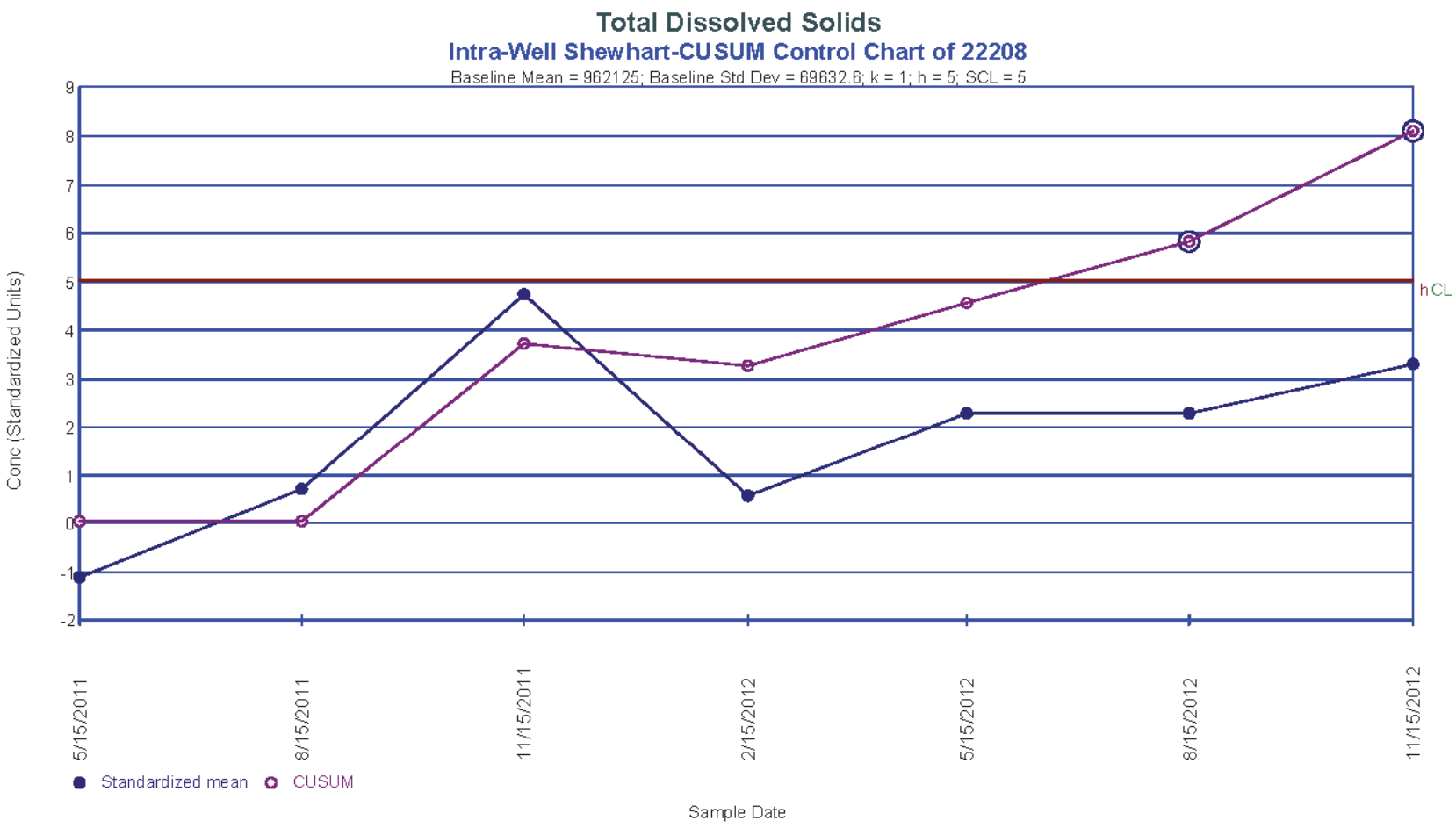


Figure A.5.5–31. Intra-Well Shewhart-CUSUM Control Chart (Total Dissolved Solids 22208)

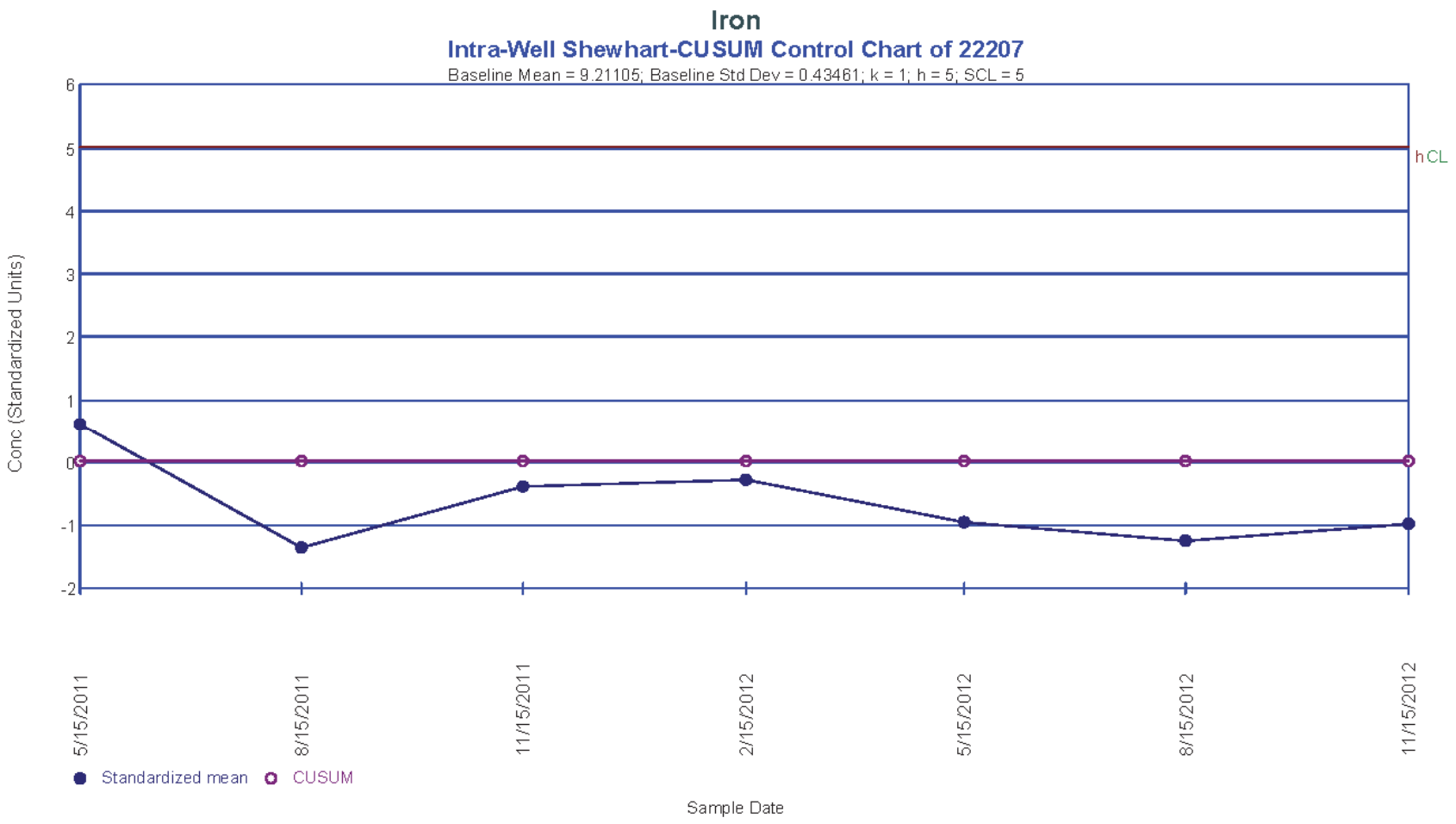


Figure A.5.5–32. Intra-Well Shewhart-CUSUM Control Chart (Iron 22207)

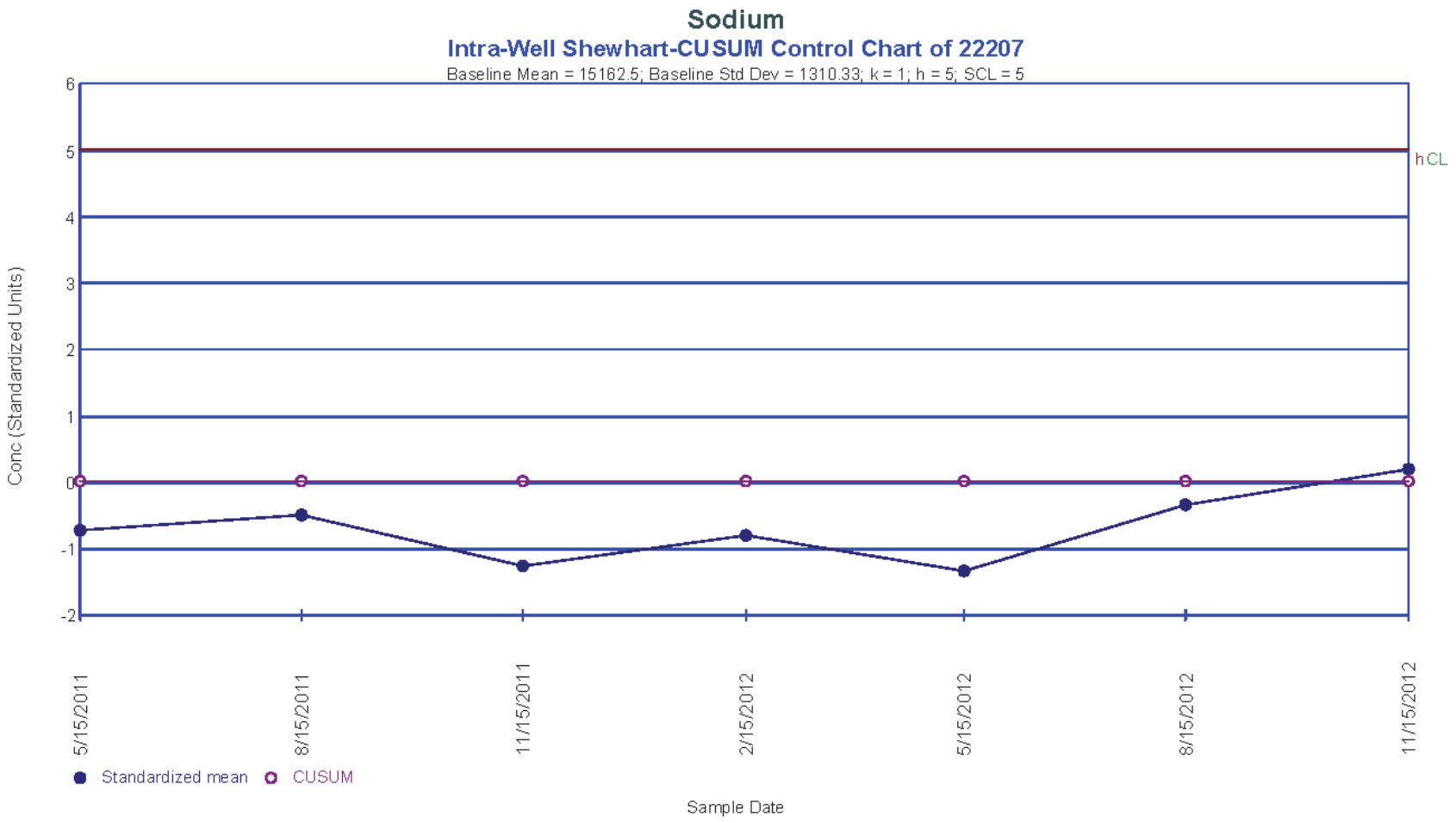


Figure A.5.5–33. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22207)

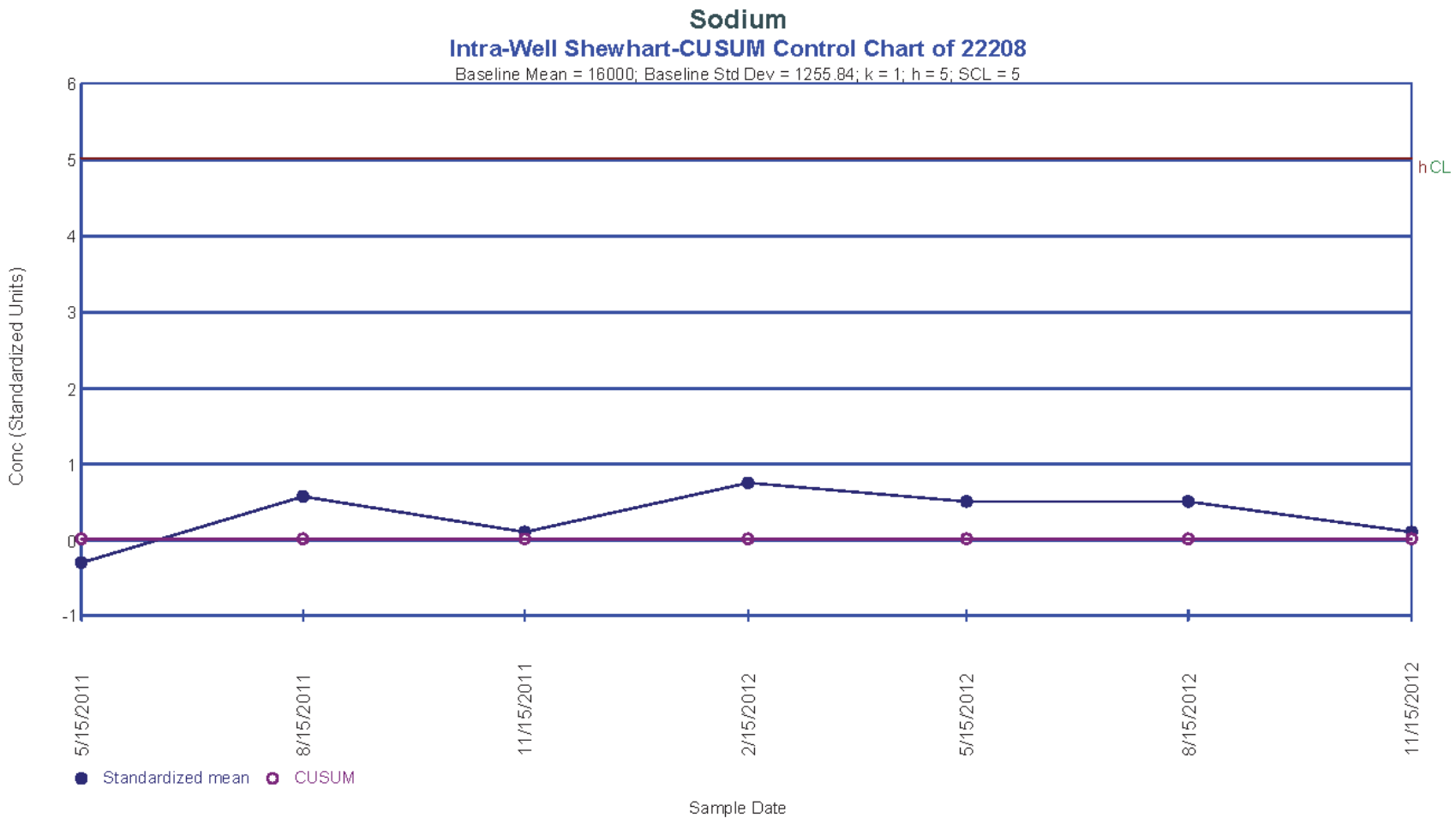


Figure A.5.5–34. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22208)

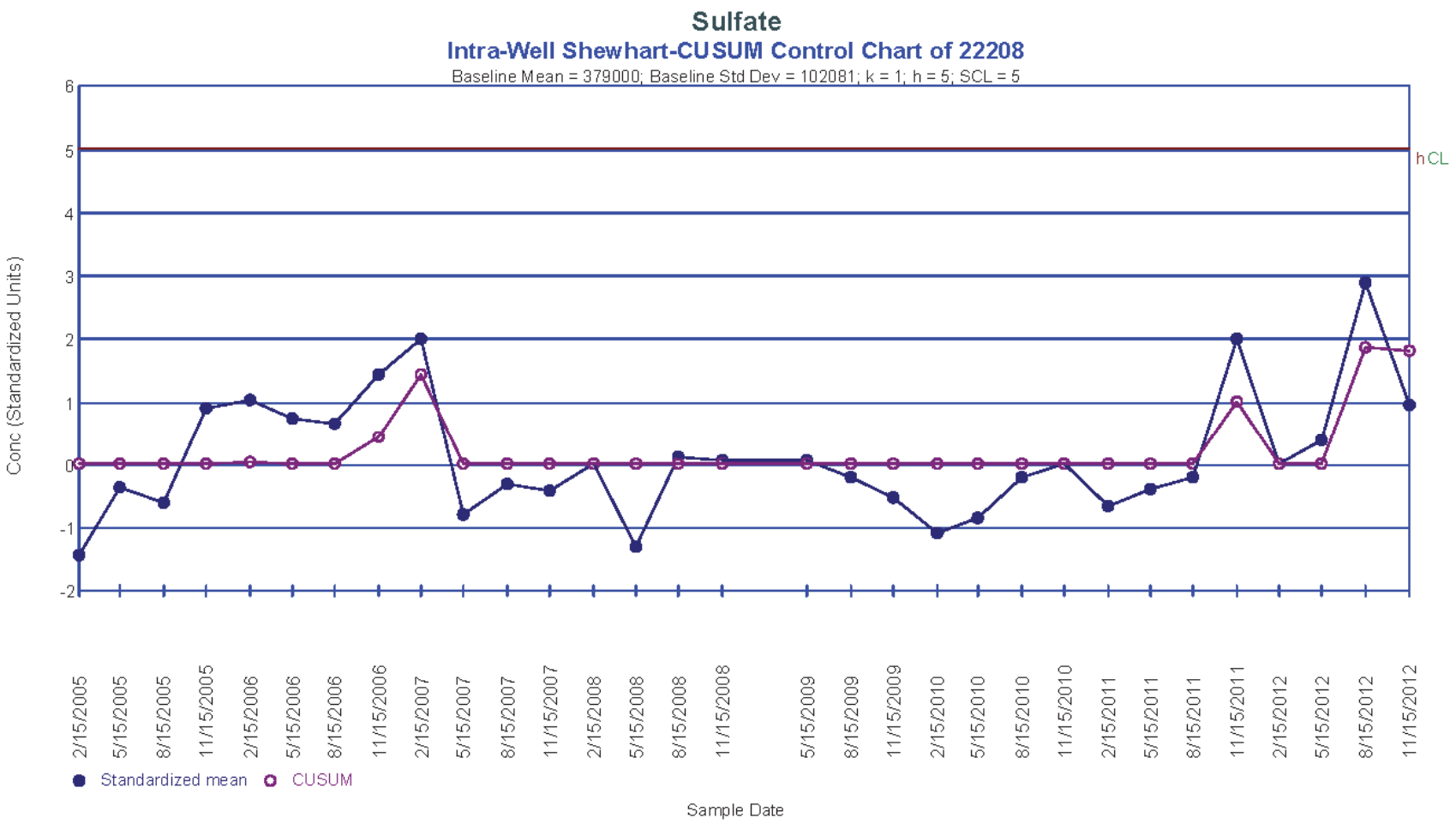


Figure A.5.5–35. Intra-Well Shewhart-CUSUM Control Chart (Sulfate 22208)

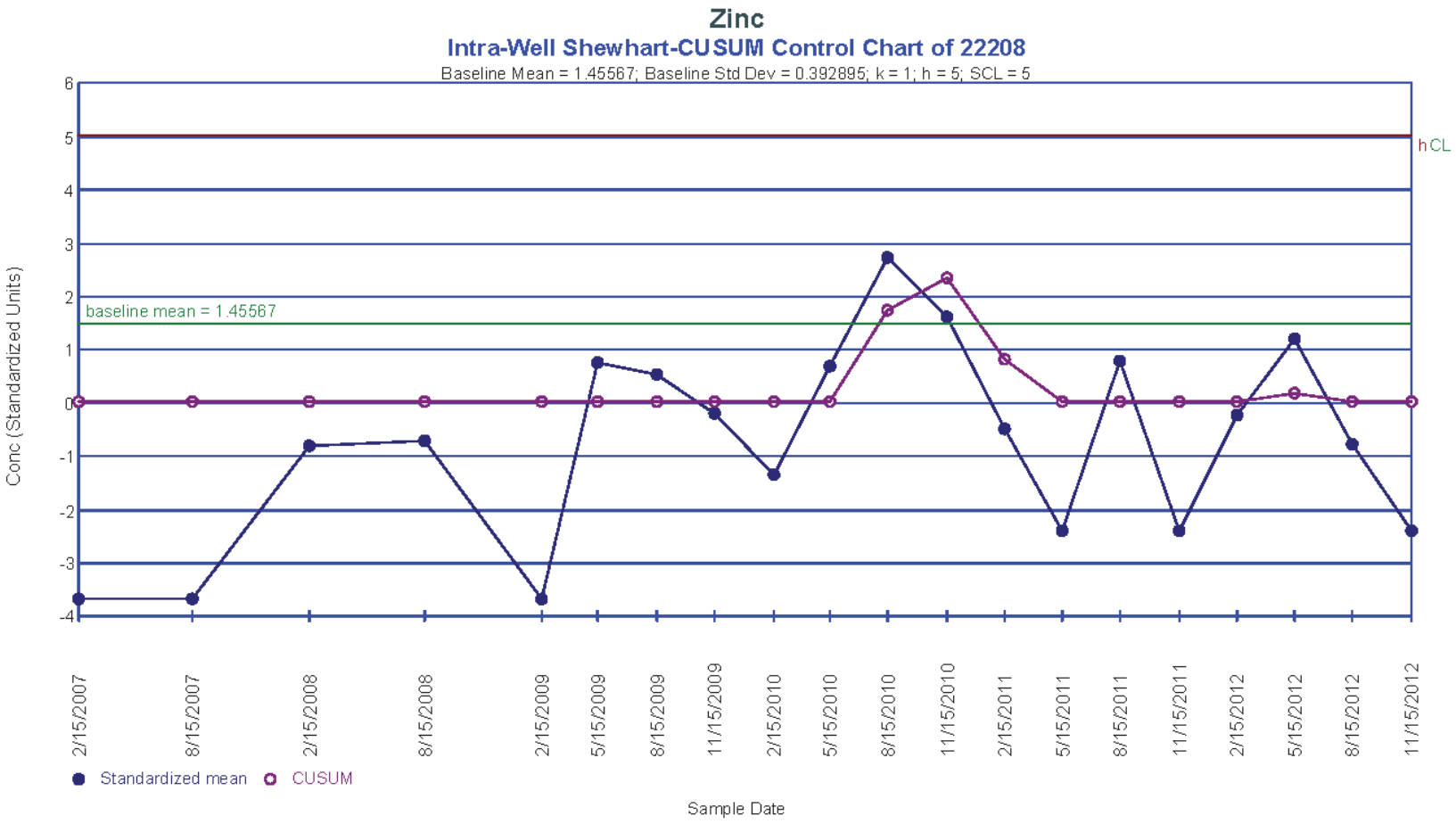


Figure A.5.5–36. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22208)

Sub-attachment A.5.6

Cell 6

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The following information is provided in this sub-attachment:

- Quarterly monitoring summary statistics (refer to Table A.5.6–1)
- Annual LCS sample summary information for detected parameters (refer to Table A.5.6–2)
- LCS monthly accumulation volumes (refer to Figure A.5.6–1)
- LDS monthly accumulation volumes (refer to Figure A.5.6–2)
- OSDF horizontal till well 12343 water yield (refer to Figure A.5.6–3)
- GMA water levels and uranium concentration versus time (refer to Figures A.5.6–4 and A.5.6–5)
- Plots of concentration versus time (refer to Figures A.5.6–6A to A.5.6–28B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.6–29)
- Control charts (refer to Figures A.5.6–30 to A.5.6–35)

A.5.6.1 Quarterly Monitoring Results

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within the cell is sampled in the LCS and LDS. Water quality beneath the cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present the results.

In 2012, 23 parameters were sampled in the LCS, LDS, and GMA wells of each cell. HTWs in all cells were sampled for arsenic, uranium, sodium, and sulfate.

As shown in Table A.5.6–1, and summarized below, 10 parameters (uranium, alkalinity, sulfate, TDS, TOC, arsenic, boron, iron, magnesium, and selenium) have upward trends in the HTW and/or GMA wells based on the Mann-Kendall test for trend.

Parameters with upward concentration trends in the HTW and GMA Wells of Cell 6

Parameter	HTW[a] 12343	GMA-U[a] 22209	GMA-D[a] 22210
Uranium	Up		
Alkalinity			Up
Sulfate	Up		Up
TDS			Up
TOC		Up	Up
Arsenic			Up
Boron		Up	Up
Iron			Up
Magnesium		Up	
Selenium			Up

[a] HTW = horizontal till well, GMA-U = upgradient Great Miami Aquifer, GMA-D = downgradient Great Miami Aquifer; TDS = total dissolved solids; TOC = total organic carbon.
No entry indicates that the trend was not up.

The (uranium-sodium) bivariate plot for the Cell 6 LCS, LDS, and HTW is provided in Figure A.5.6–29. The plot shows that the chemical signature for uranium-sodium in the LCS, LDS, and HTW are separate and distinct, indicating that mixing between the horizons is not occurring. Therefore, the increasing concentration trends measured beneath Cell 6 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

A.5.6.2 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 2009) defines the process of creating a Shewart-CUSUM control chart. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected, the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared "out of control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit.

A minimum of eight samples are recommended for use in ChemStat software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat software plots both a CUSUM control limit (h) and a SCL on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL.

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat software though, by default, plots both the SCL and CUSUM (h) control limits on the charts. As a "work-a-round", the SCL limit was defined as 5 to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

As shown in Table A.5.6–1 in gray shading, five parameters in the HTW and/or GMA wells of Cell 6 (chloride, lithium, iron, uranium, and manganese) meet the criteria for control charts (i.e., more than eight samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in six control charts.

Control charts are presented in Figures A.5.6–30 to A.5.6–35. All of the control charts exhibit "in control" conditions.

Parameter and Monitoring Point[a]	Assessment	Figure Number
Uranium in the GMA-D	In Control	A.5.6–30
Chloride in the GMA-U	In Control	A.5.6–31
Iron in the GMA-U	In Control	A.5.6–32
Lithium in the GMA-U	In Control	A.5.6–33
Lithium in the GMA-D	In Control	A.5.6–34
Manganese in the GMA-D	In Control	A.5.6–35

[a] GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer

A.5.6.3 Annual LCS Sample Results

Annual LCS sampling results for Cell 6 are provided in Table A.5.6–2 for those parameters detected at least once, and not being sampled quarterly. No new Appendix I parameters were detected in 2012 at Cell 6.

A.5.6.4 Cell 6 LDS Sampling

In addition to the 23 parameters being sampled for quarterly in the LCS, LDS, and GMA wells, the Cell 6 LDS is also being sampled for chromium.

Chromium was detected for the first time in the LCS of Cell 6 in 2010. In 2011 it was detected for a second time in the LCS and therefore added to the LDS sampling list. Sampled for in the second, third, and fourth quarters of 2012, chromium was not detected in the LDS of Cell 6 in 2012.

A.5.6.5 Summary and Conclusions

- Ten parameters monitored quarterly have an upward concentration trend in the HTW and/or GMA wells of Cell 6: uranium, alkalinity, sulfate, TDS, TOC, arsenic, boron, iron, magnesium, and selenium.
- Separate and distinct chemical signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 6 indicate that water is not mixing between the horizons. Therefore, upward concentration trends beneath Cell 6 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell and not to cell performance.
- Six control charts were constructed for Cell 6 parameters. All of the control charts exhibit “in control” conditions.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 6 in 2012.
- Sampled for three times in 2012, chromium was not detected in the LDS of Cell 6 in 2012.

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Table A.5.6–1. Summary Statistics for Cell 6

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Total Uranium (µg/L)	LCS	12343C	36	36	100	43.3	197	134	31	Undefined	None	Detected	
	LDS	12343D	36	36	100	3.1	43.7	23.5	8.6	Normal	Up	Detected	
	HTW	12343	36	36	100	6.32	24.2	12	4	LogNormal	Up	Detected	
	GMA-U	22209	36	40	90.0	ND	2.43	0.508	0.454	Undefined	Down	Not Detected	
	GMA-D	22210	39	41	95.1	ND	0.994	0.641	0.182	Normal	None	Not Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12343C	22	22	100	407	557	466	42	Normal	Down	Not Detected	64(Q4-03)
	LDS	12343D	18	18	100	161	549	278	137	Undefined	Down	Detected	
	GMA-U	22209	9	9	100	225	351	334	42	Undefined	None	Not Detected	
	GMA-D	22210	8	8	100	405	428	414	9	Normal	Up	Not Detected	
Chloride (mg/L)	LCS	12343C	22	22	100	20.1	139	116	32	Undefined	Up	Detected	
	LDS	12343D	18	18	100	51.5	157	96.8	44.6	Undefined	Up	Detected	
	GMA-U	22209	9	9	100	17.9	33.4	25.7	5.3	Normal	None	Not Detected	
	GMA-D	22210	8	8	100	25.0	34.6	29.0	3.1	Normal	None	Not Detected	
Nitrate, Nitrite (mg/L)	LCS	12343C	18	25	72.0	ND	4.67	1.33	1.44	Undefined	Up	Detected	
	LDS	12343D	10	18	55.6	ND	4.1	0.480	1.45	Undefined	Up	Detected	
	GMA-U	22209	1	9	11.1	ND	0.50	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-D	22210	0	8	0	ND	0.025	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Sulfate (mg/L)	LCS	12343C	36	36	100	491	4800	2520	1000	Normal	Up	Detected	
	LDS	12343D	36	36	100	1300	3910	2260	850	Undefined	Up	Detected	
	HTW	12343	30	31	96.8	ND	595	450	80	Normal	Up	Detected	
	GMA-U	22209	39	39	100	2.07	406	184	74	Undefined	None	Not Detected	
	GMA-D	22210	39	39	100	127	578	285	90	Undefined	Up	Detected	
Total Dissolved Solids (mg/L)	LCS	12343C	24	24	100	267	6100	5220	1780	Undefined	Up	Detected	
	LDS	12343D	16	16	100	3690	6340	5430	720	Normal	Up	Detected	
	GMA-U	22209	15	15	100	573	718	638	40	Normal	Down	Detected	876(Q3-11)
	GMA-D	22210	15	15	100	827	1010	927	48	Normal	Up	Detected	
Total Organic Carbon (mg/L)	LCS	12343C	33	36	91.7	ND	3.55	2.12	0.59	Normal	None	Not Detected	14.6(Q4-03)
	LDS	12343D	34	36	94.4	ND	10.4	4.64	2.13	Normal	Down	Detected	
	GMA-U	22209	28	40	70.0	ND	2.28	1.27	0.46	Normal	Up	Detected	
	GMA-D	22210	29	40	72.5	ND	2.50	1.36	0.49	Normal	Up	Detected	
Total Organic Halogens (mg/L)	LCS	12343C	24	36	66.7	ND	0.060	0.0139	0.0116	LogNormal	None	Detected	
	LDS	12343D	27	36	75.0	ND	0.0446	0.0235	0.0114	Normal	None	Not Detected	D.091(Q2-10)
	GMA-U	22209	10	40	25.0	ND	0.0377	0.00303	0.00850	Undefined	None	Detected	
	GMA-D	22210	9	40	22.5	ND	0.059	0.00305	0.00962	Undefined	None	Not Detected	
Arsenic (mg/L)	LCS	12343C	6	27	22.2	ND	0.093	0.00375	0.0262	Undefined	None	Detected	
	LDS	12343D	6	25	24.0	ND	0.023	0.00375	0.00482	Undefined	None	Not Detected	
	HTW	12343	1	23	4.4	ND	0.0330	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-U	22209	5	15	33.3	ND	0.0396	0.0025	0.0120	Undefined	None	Detected	
	GMA-D	22210	6	24	25.0	ND	0.0381	0.0025	0.0107	Undefined	Up	Detected	
Barium (mg/L)	LCS	12343C	22	22	100	0.0143	0.0868	0.0341	0.0190	LogNormal	Down	Detected	
	LDS	12343D	18	18	100	0.0127	0.0670	0.0269	0.0132	LogNormal	Down	Detected	
	GMA-U	22209	8	8	100	0.0738	0.0965	0.0864	0.0087	Normal	None	Not Detected	
	GMA-D	22210	8	8	100	0.0332	0.0459	0.0388	0.0046	Normal	None	Not Detected	
Boron (mg/L)	LCS	12343C	36	36	100	0.0566	1.37	0.766	0.235	Undefined	None	Detected	
	LDS	12343D	36	36	100	0.289	2.38	0.398	0.363	Undefined	None	Detected	
	GMA-U	22209	35	40	87.5	ND	0.0447	0.0369	0.0080	Undefined	Up	Not Detected	
	GMA-D	22210	37	40	92.5	ND	0.0468	0.0343	0.0075	Undefined	Up	Detected	

Table A.5.6−1 (continued). Summary Statistics for Cell 6

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Calcium (mg/L)	LCS	12343C	22	22	100	225	996	506	146	Undefined	None	Not Detected	
	LDS	12343D	18	18	100	302	518	400	64	Normal	None	Not Detected	
	GMA-U	22209	8	8	100	136	242	145	36	Undefined	None	Not Detected	
	GMA-D	22210	8	8	100	212	235	223	7	Normal	None	Not Detected	
Cobalt (mg/L)	LCS	12343C	11	27	40.7	ND	0.0029	0.0005	0.0007	Undefined	Down	Detected	
	LDS	12343D	10	25	40.0	ND	0.0105	0.0005	0.0020	Undefined	Down	Not Detected	
	GMA-U	22209	0	15	0	ND	0.0005	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22210	0	15	0	ND	0.0005	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Copper (mg/L)	LCS	12343C	16	23	69.6	ND	0.0254	0.0099	0.0068	Normal	None	Not Detected	
	LDS	12343D	12	20	60.0	ND	0.0224	0.0105	0.0072	Normal	None	Not Detected	
	GMA-U	22209	6	8	75.0	ND	0.0101	0.0041	0.0036	Normal	None	Not Detected	
	GMA-D	22210	6	8	75.0	ND	0.0109	0.0047	0.0036	Normal	Down	Detected	
Iron (mg/L)	LCS	12343C	13	27	48.2	ND	4.48	0.0650	1.50	Undefined	Down	Detected	
	LDS	12343D	17	25	68.0	ND	3.69	0.0778	1.10	Undefined	Down	Detected	
	GMA-U	22209	15	15	100	2.24	5.58	4.09	0.82	Normal	None	Not Detected	
	GMA-D	22210	15	15	100	1.57	4.55	2.66	1.00	Normal	Up	Detected	
Lithium (mg/L)	LCS	12343C	24	24	100	0.0234	0.267	0.151	0.069	Normal	Up	Detected	
	LDS	12343D	24	24	100	0.0703	0.195	0.123	0.039	Normal	Up	Detected	
	GMA-U	22209	15	15	100	0.00486	0.00739	0.00578	0.00070	LogNormal	None	Not Detected	
	GMA-D	22210	15	15	100	0.00631	0.00797	0.0073	0.0005	Normal	None	Not Detected	
Magnesium (mg/L)	LCS	12343C	22	22	100	92.4	837	458	260	Undefined	Up	Detected	
	LDS	12343D	18	18	100	130	510	230	154	Undefined	Up	Detected	
	GMA-U	22209	8	8	100	27.0	38.8	31.2	3.4	LogNormal	Up	Not Detected	
	GMA-D	22210	8	8	100	50.8	55.5	53.3	1.9	Normal	None	Not Detected	
Manganese (mg/L)	LCS	12343C	9	27	33.3	ND	1.41	0.0050	0.285	Undefined	None	Not Detected	
	LDS	12343D	10	25	40.0	ND	3.24	0.0090	0.646	Undefined	Down	Not Detected	
	GMA-U	22209	15	15	100	0.243	0.748	0.268	0.125	Undefined	None	Not Detected	
	GMA-D	22210	24	24	100	0.0735	0.420	0.214	0.098	Normal	None	Not Detected	
Nickel (mg/L)	LCS	12343C	20	27	74.1	ND	0.0319	0.00391	0.00988	Undefined	Down	Detected	
	LDS	12343D	19	25	76.0	ND	0.0572	0.0120	0.0116	LogNormal	None	Detected	
	GMA-U	22209	0	15	0	ND	0.00075	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22210	22	24	91.7	ND	0.0099	0.00374	0.00258	LogNormal	None	Detected	
Potassium (mg/L)	LCS	12343C	22	22	100	9.00	33.1	24.1	6.6	Normal	Up	Detected	75.5(Q4-03)
	LDS	12343D	18	18	100	24.5	69.8	40.0	13.8	Undefined	Up	Detected	
	GMA-U	22209	8	8	100	3.00	3.78	3.33	0.24	Normal	None	Not Detected	
	GMA-D	22210	8	8	100	3.14	3.62	3.38	0.14	Normal	None	Not Detected	

Table A.5.6−1 (continued). Summary Statistics for Cell 6

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Selenium (mg/L)	LCS	12343C	8	27	29.6	ND	0.140	0.00625	0.0281	Undefined	None	Not Detected	
	LDS	12343D	5	25	20.0	ND	0.0545	0.00805	0.0110	LogNormal	None	Not Detected	
	GMA-U	22209	0	15	0	ND	0.003645	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22210	1	15	6.7	ND	0.0077	Insufficient	Insufficient	Undefined	Up	Detected	
Sodium (mg/L)	LCS	12343C	27	27	100	23.1	107	62.6	17.3	Normal	Up	Not Detected	
	LDS	12343D	25	25	100	372	532	445	48	Normal	Down	Detected	109(Q4-03)
	HTW	12343	23	23	100	33.9	66.0	49.8	10.2	Normal	Down	Detected	
	GMA-U	22209	15	15	100	15.2	22.5	18.4	2.1	Normal	Down	Detected	
	GMA-D	22210	15	15	100	16.2	20.4	18.2	1.1	Normal	Down	Not Detected	
Zinc (mg/L)	LCS	12343C	9	27	33.3	ND	0.0432	0.0127	0.0092	LogNormal	None	Not Detected	
	LDS	12343D	17	25	68.0	ND	2.61	0.371	0.572	LogNormal	Up	Detected	
	GMA-U	22209	7	15	46.7	ND	0.0133	0.00472	0.00372	Undefined	None	Not Detected	
	GMA-D	22210	19	24	79.2	ND	0.0244	0.0111	0.0058	LogNormal	Down	Not Detected	

Note 1: Shading identifies a horizontal till well or Great Miami Aquifer well, with more than 8 samples, normal or lognormal distribution, no trend, and no serial correlation. These wells meet control chart criteria.

Note 2: Data used in this table has been standardized to quarterly.

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]ND = not detected; NA = not applicable

[c]Averages were determined based on the distribution assumption.

[d]Insufficient is used for Distribution Type, Trend, or Serial Correlation whenever there is not enough data to run the test, for average whenever there is less than 4 detetions, and for standard deviation whenever there are less than 5 detections.

[e]Data distribution based on the Shapiro-Wilk statistic.

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[f]Trend based on nonparametric Mann-Kendall procedure.

[g]Serial correlation based on Rank Von Neumann test.

[h]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 25).

[i]Q = quarterly

Table A.5.6–2. Cell 6 Annual LCS Sample Summary Information for Detected Parameters

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	DETECTED IN 2012	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)
General Chemistry											
Ammonia (mg/L)	10	3	30.0	No	0.0198	1	0.369	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganic											
Chromium (mg/L)	10	2	20.0	No	0.00288	0.0058	0.0043	0.022 mg/L[g](0)	0.021 mg/L(0)	0.0046 mg/L(1)	0.818 mg/L(0)
Mercury (mg/L)	16	1	6.2	No	0.000338	-	-	0.002 mg/L(0)	-	-	0.0018 mg/L(0)
Vanadium (mg/L)	10	1	10.0	No	0.00088	-	-	0.038 mg/L(0)	0.012 mg/L(0)	0.005 mg/L(0)	0.299 mg/L(0)
Radionuclides											
Technetium-99 (pCi/L)	16	4	25.0	No	1.83	11.7	7.22	94 pCi/L(0)	22 pCi/L(0)	30 pCi/L(0)	6130 pCi/L(0)
Organics											
Acetone (ug/L)	9	1	11.1	No	2.66	-	-	-	-	-	-
Toluene (ug/L)	9	1	11.1	No	0.716	-	-	-	-	-	-

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on hexavalent chromium from Operable Unit 5 Record of Decision, Table 9-4.

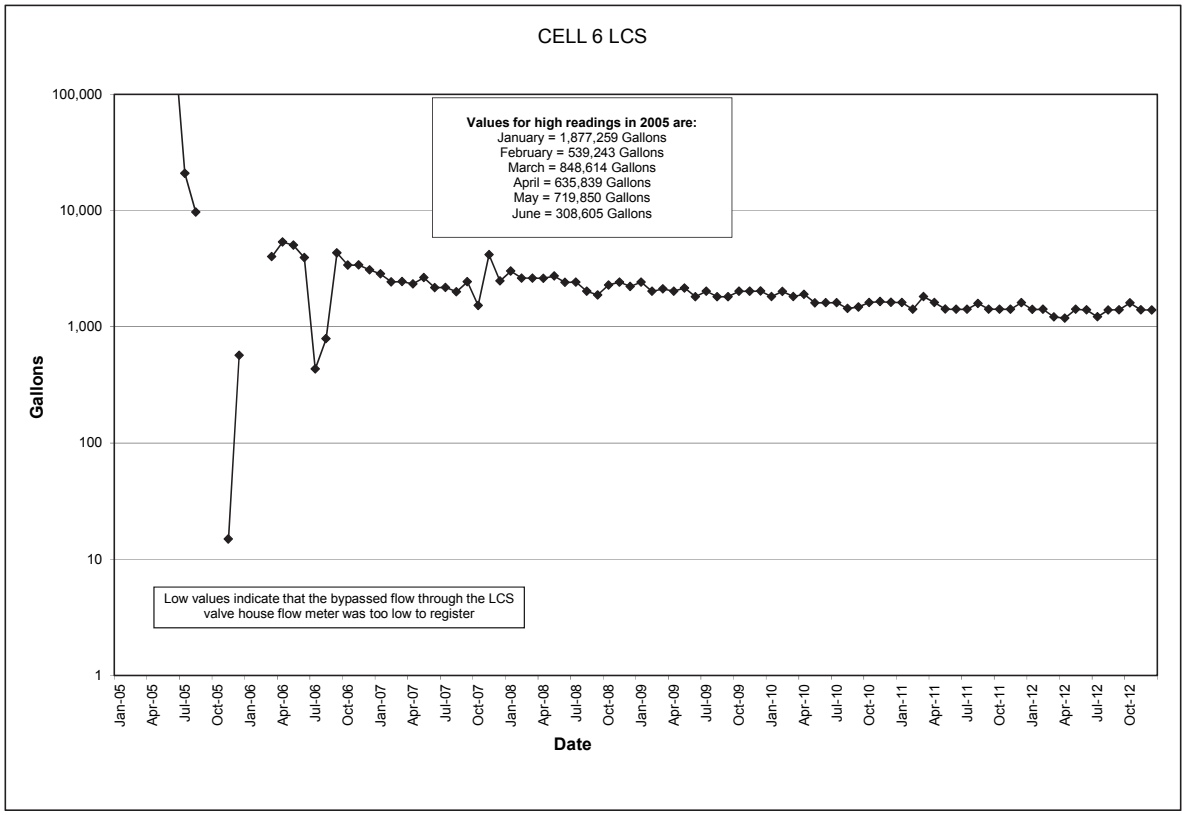


Figure A.5.6–1. Monthly Accumulation Volumes for Cell 6 LCS

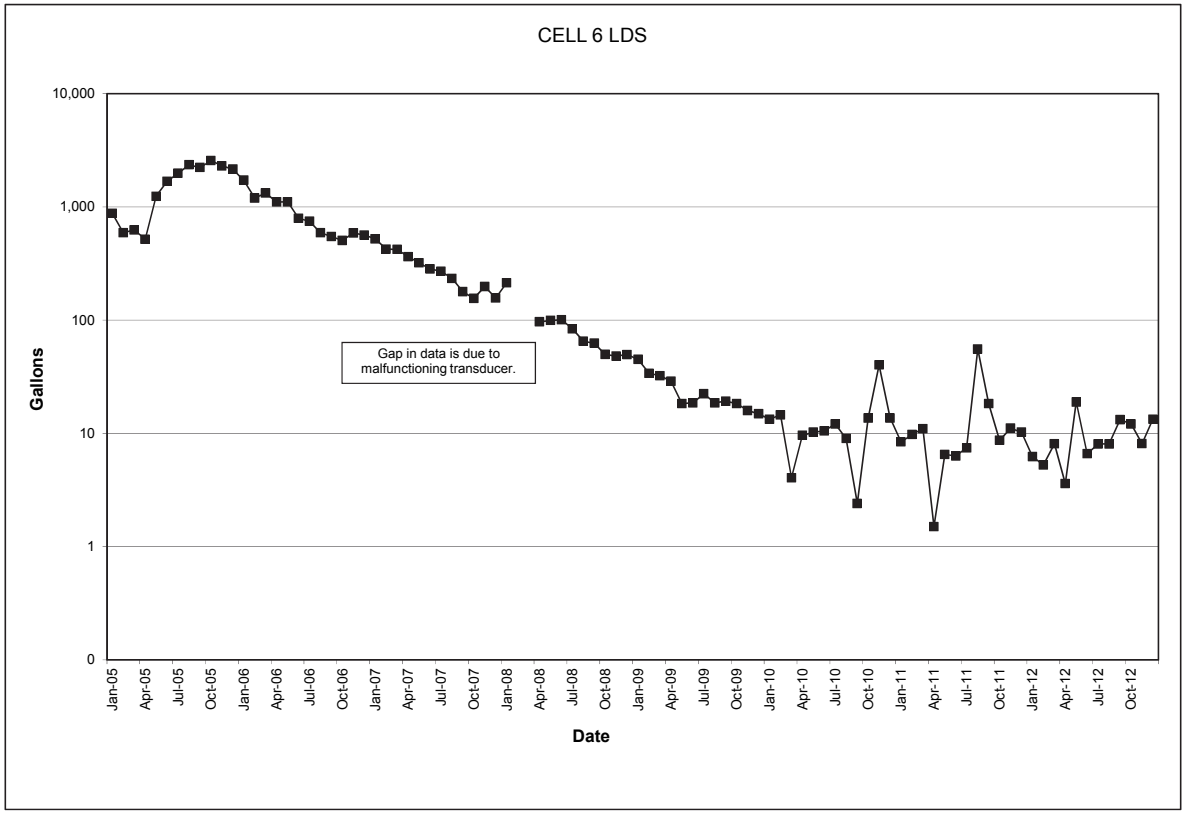
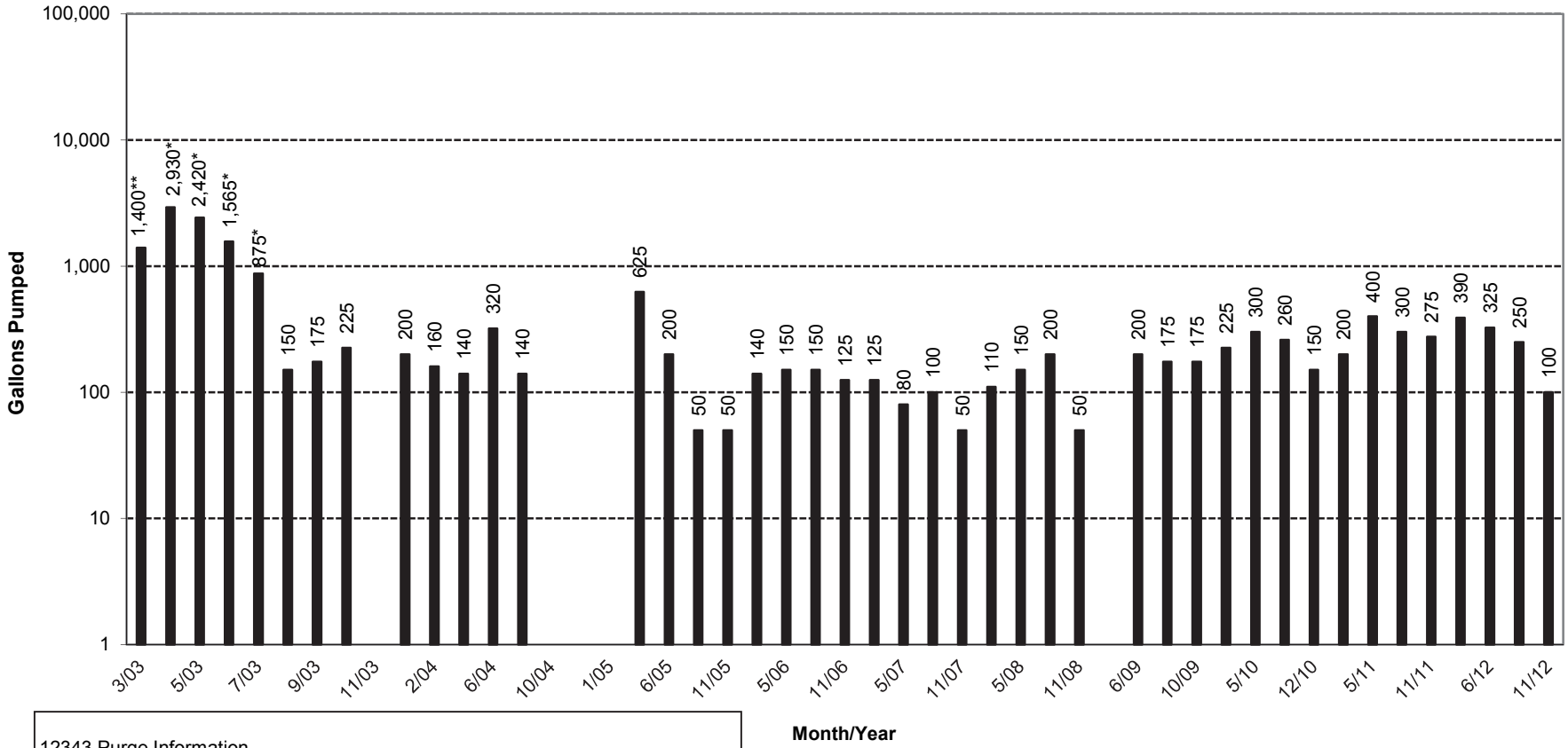


Figure A.5.6–2. Monthly Accumulation Volumes for Cell 6 LDS



12343 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
2003:	9940	n=10	994
2004:	760	n= 6	127
2005:	925	n=5	185
2006:	565	n=4	141
2007:	355	n=4	89
2008:	510	n=4	128
2009:	550	n=3	183
2010:	935	n=4	234
2011:	1175	n=4	294
2012:	1065	n=4	266
Overall:			350

*More than one purge of the well was completed during these months to drain perched water and infiltrating surface water so the compacted clay liner could be constructed.

**Excess water was pumped from this well in March 2003 for well development.

Figure A.5.6–3. OSDF Horizontal Till Well 12343 (Cell 6) Water Yield

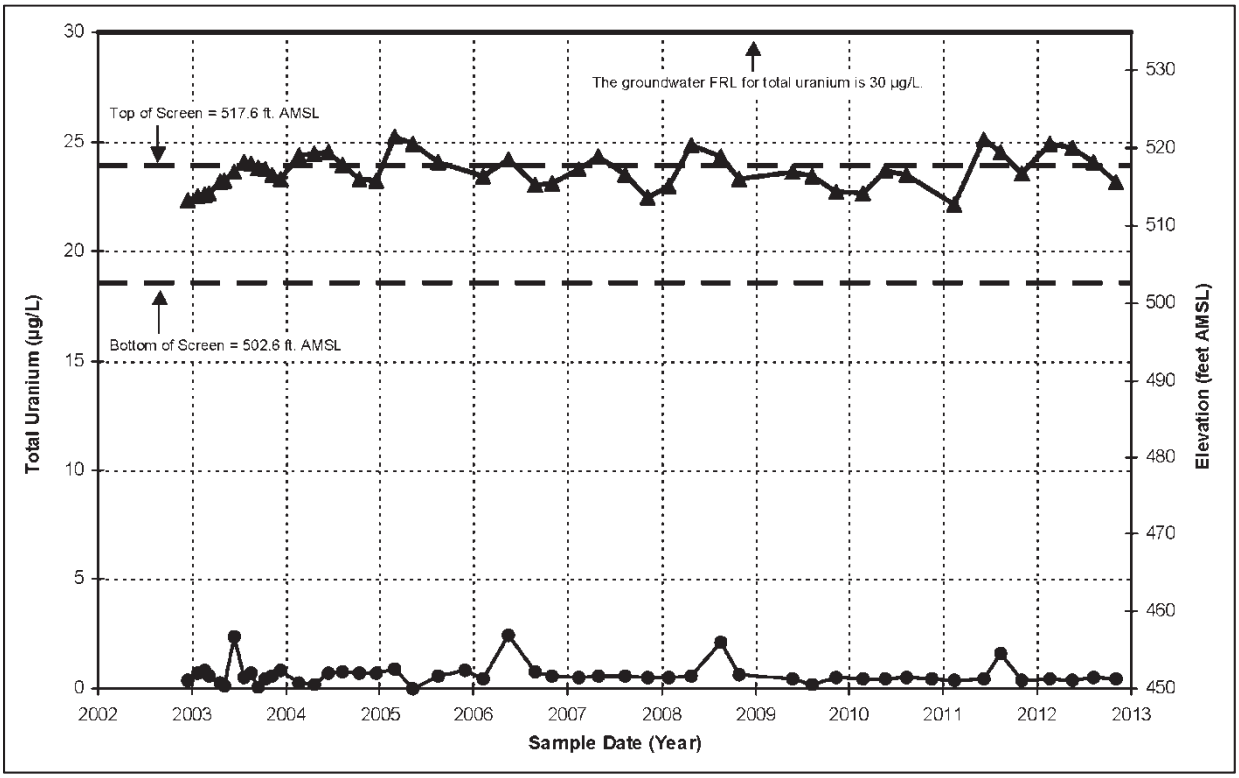


Figure A.5.6–4. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 6 Upgradient Monitoring Well 22209

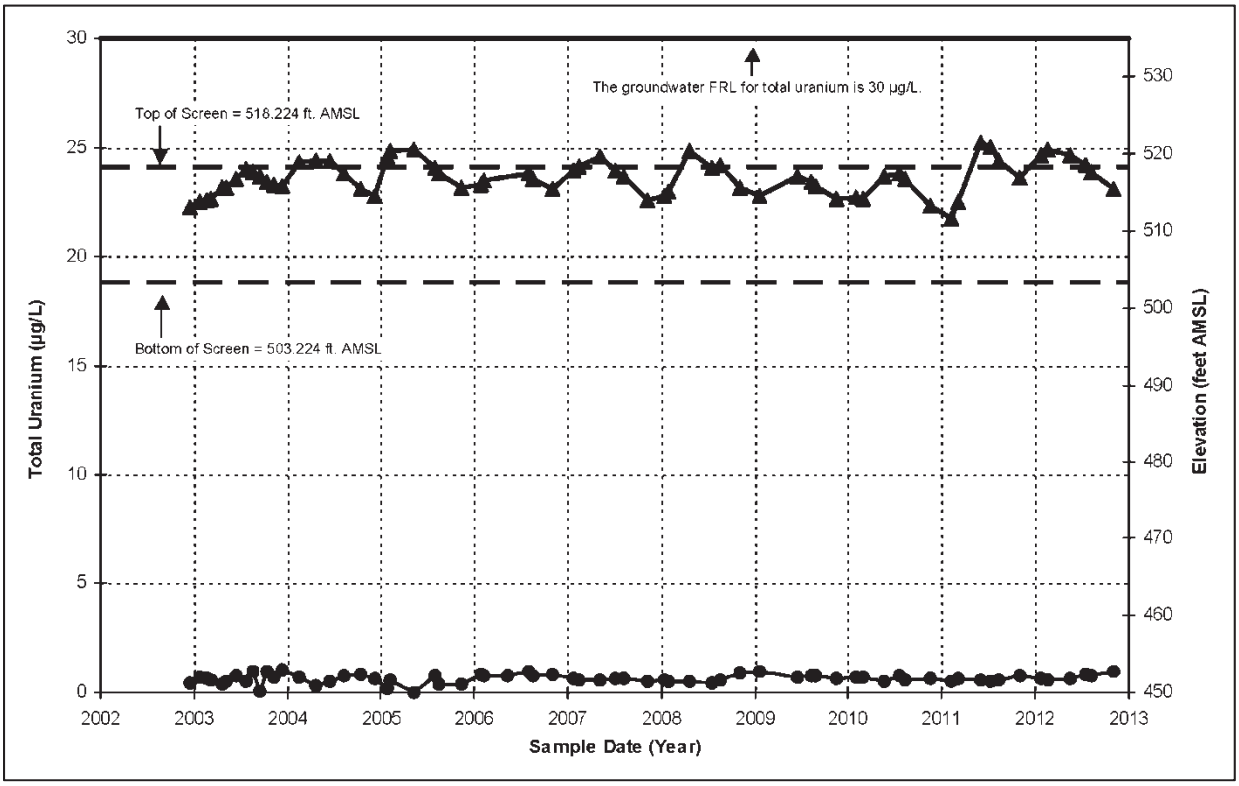


Figure A.5.6–5. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 6 Downgradient Monitoring Well 22210

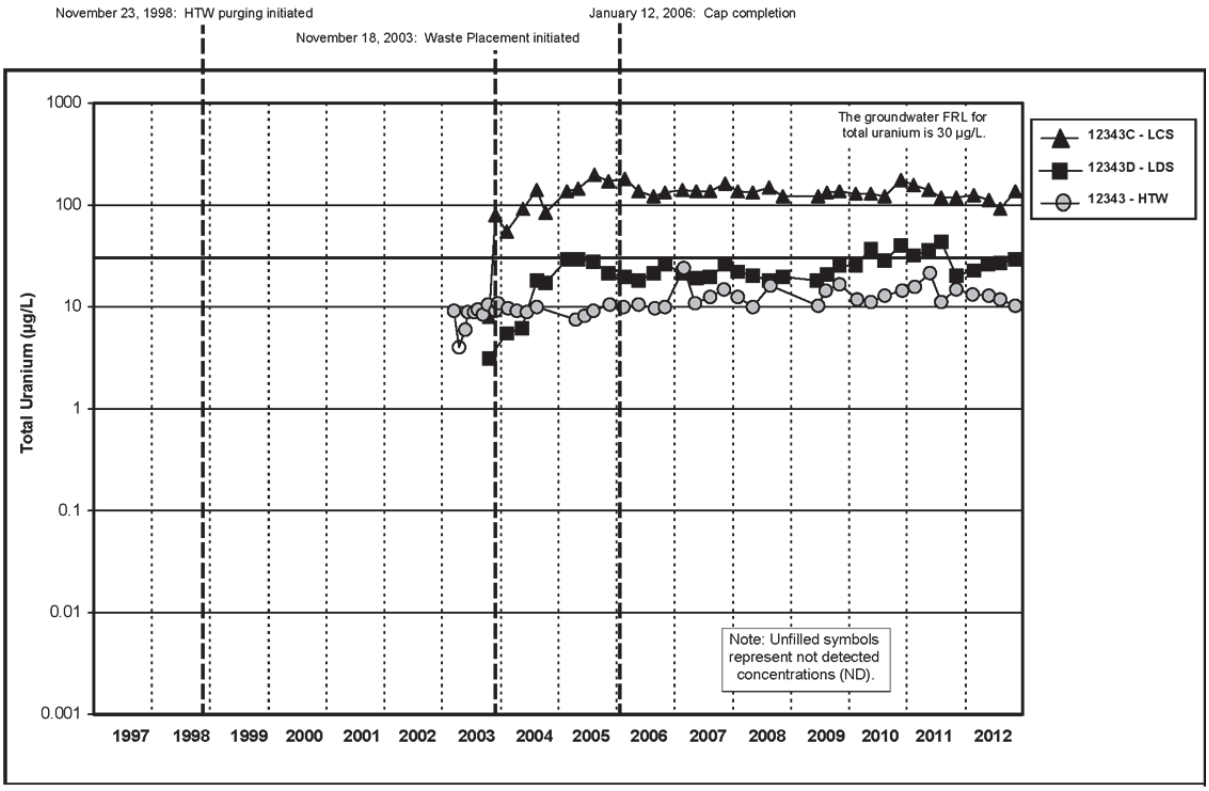


Figure A.5.6–6A. Cell 6 Uranium, Total Concentration vs. Time Plot for LCS, LDS, and HTW

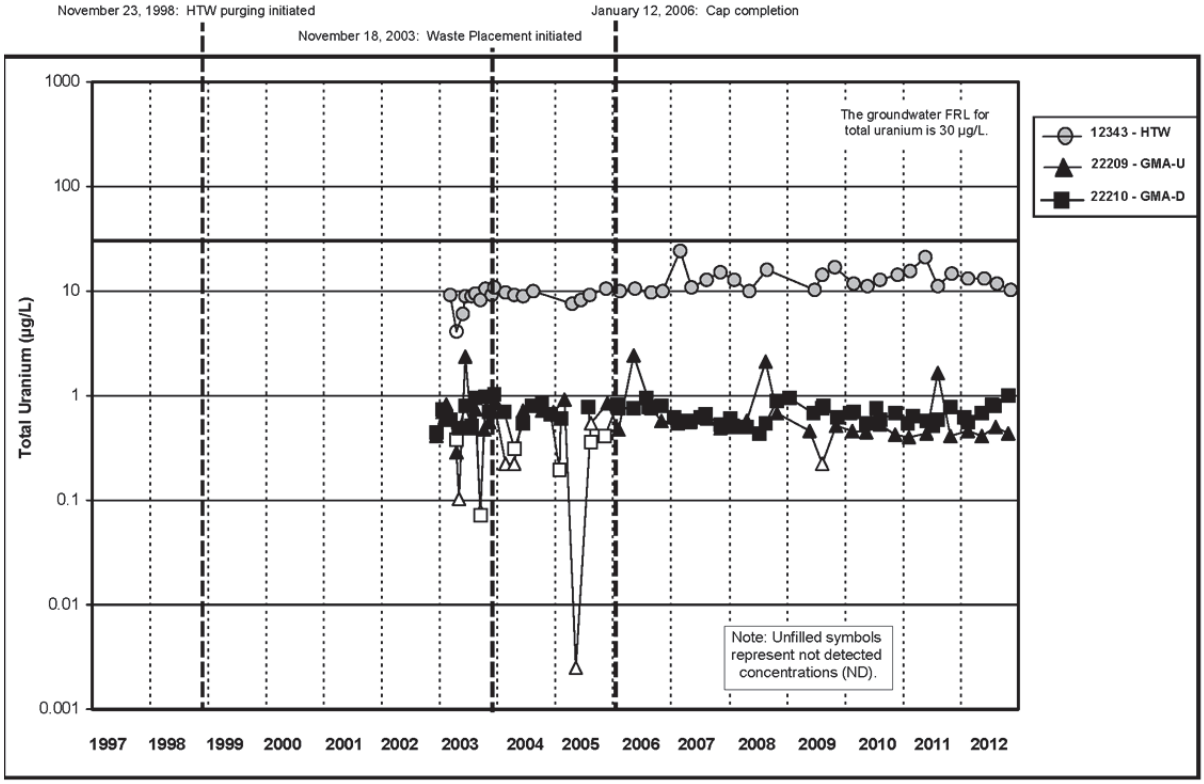


Figure A.5.6–6B. Cell 6 Uranium, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

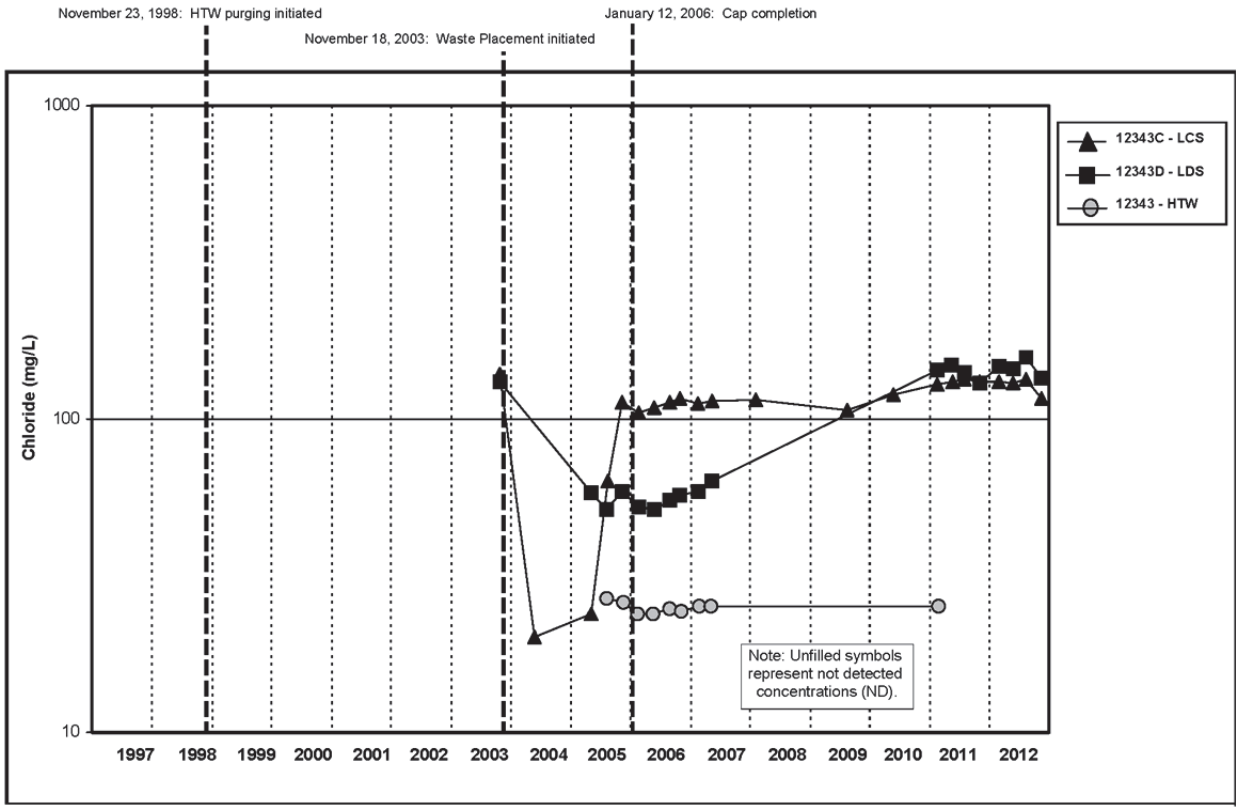


Figure A.5.6–7A. Cell 6 Chloride Concentration vs. Time Plot for LCS, LDS, and HTW

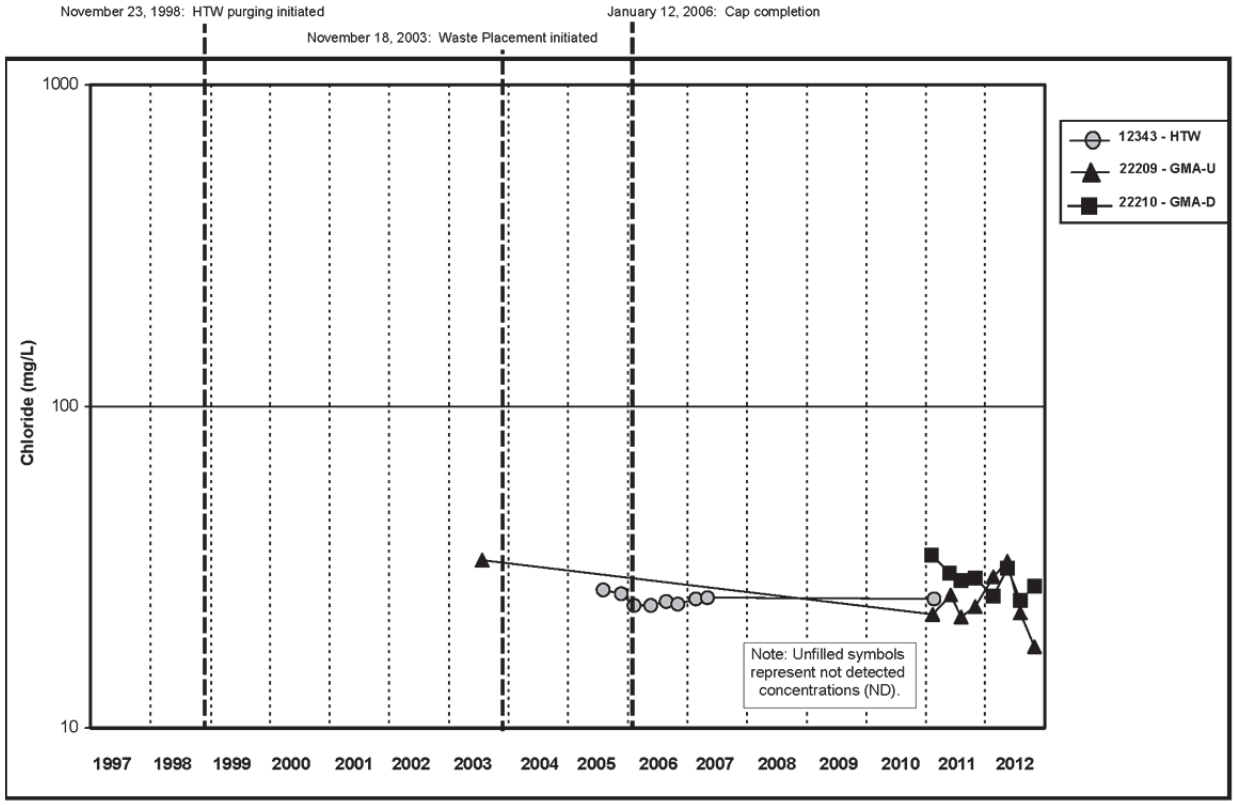


Figure A.5.6–7B. Cell 6 Chloride Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

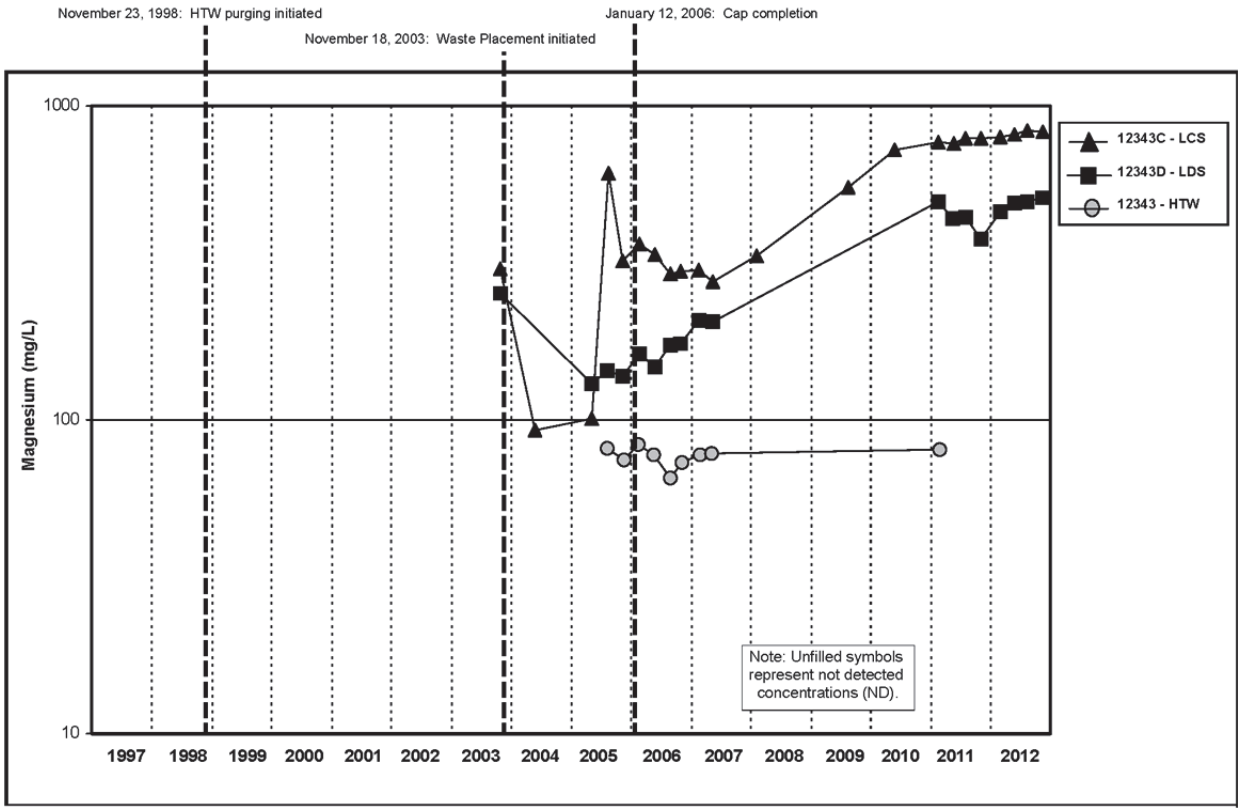


Figure A.5.6–8A. Cell 6 Magnesium Concentration vs. Time Plot for LCS, LDS, and HTW

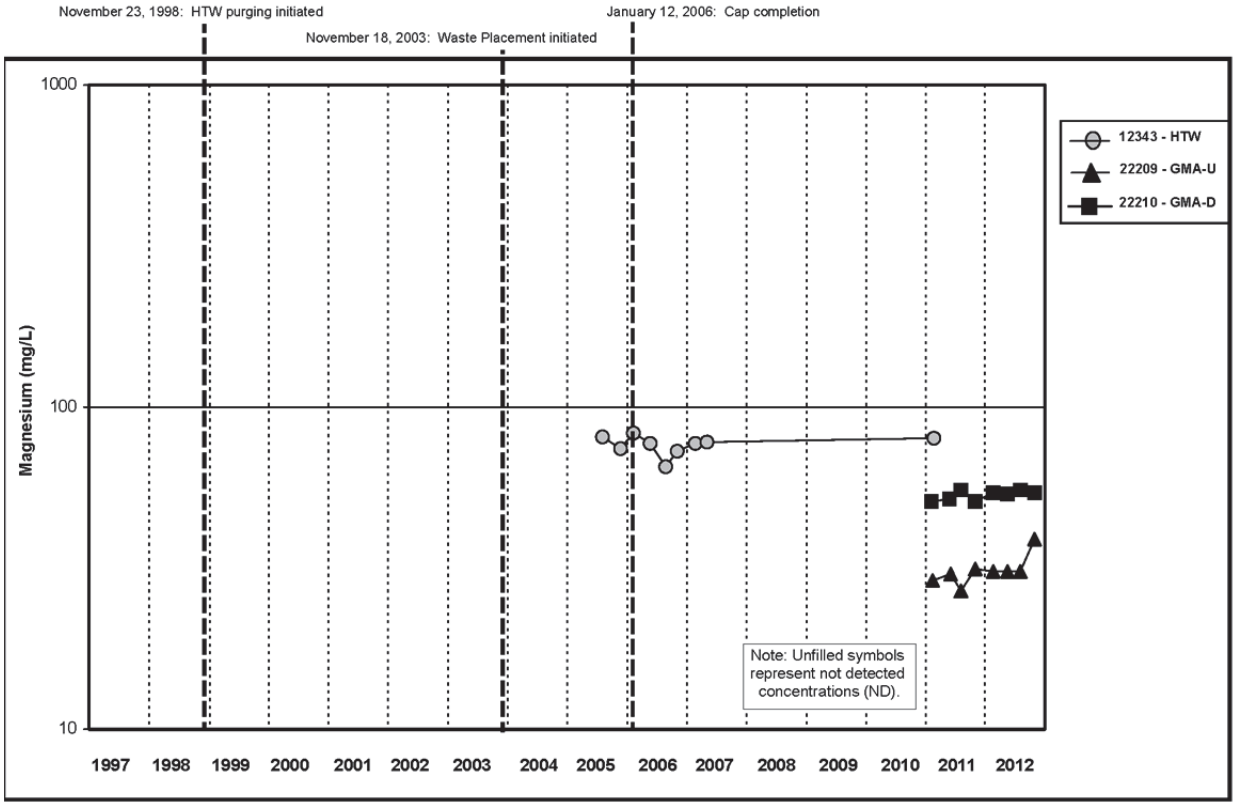


Figure A.5.6–8B. Cell 6 Magnesium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

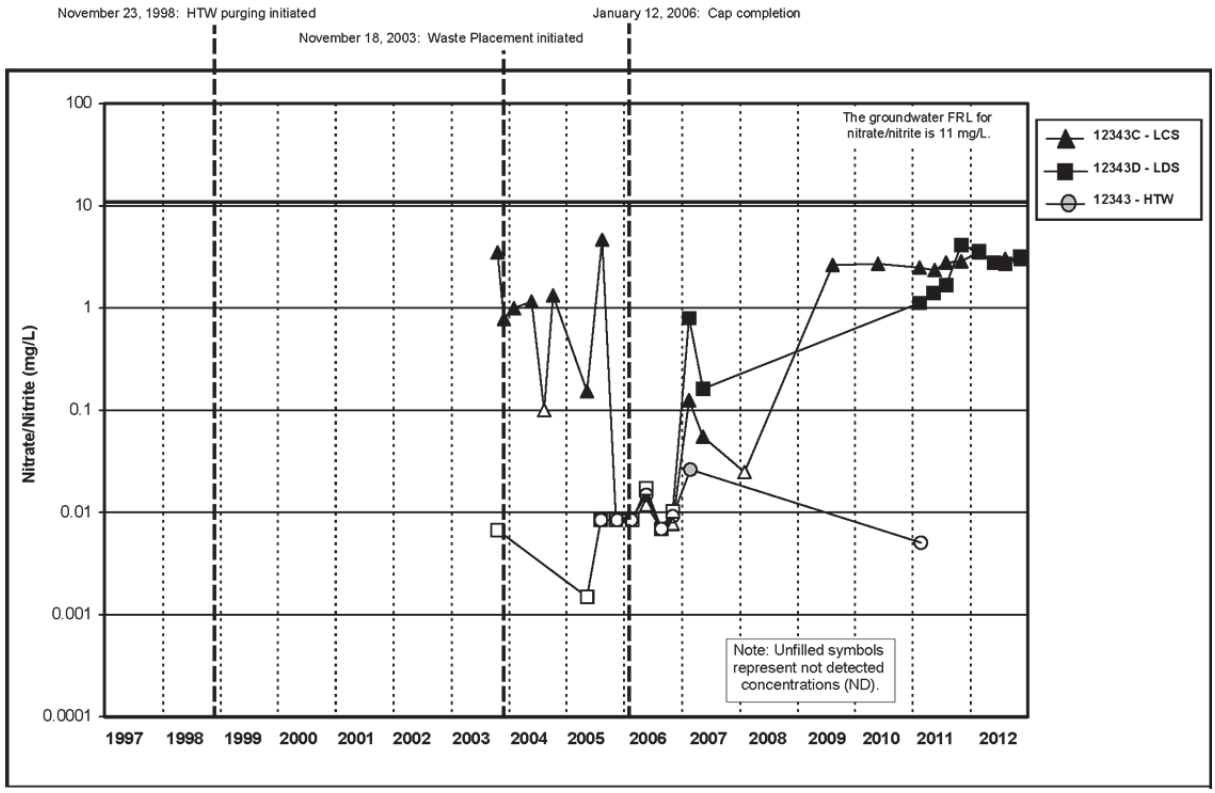


Figure A.5.6–9A. Cell 6 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for LCS, LDS, and HTW

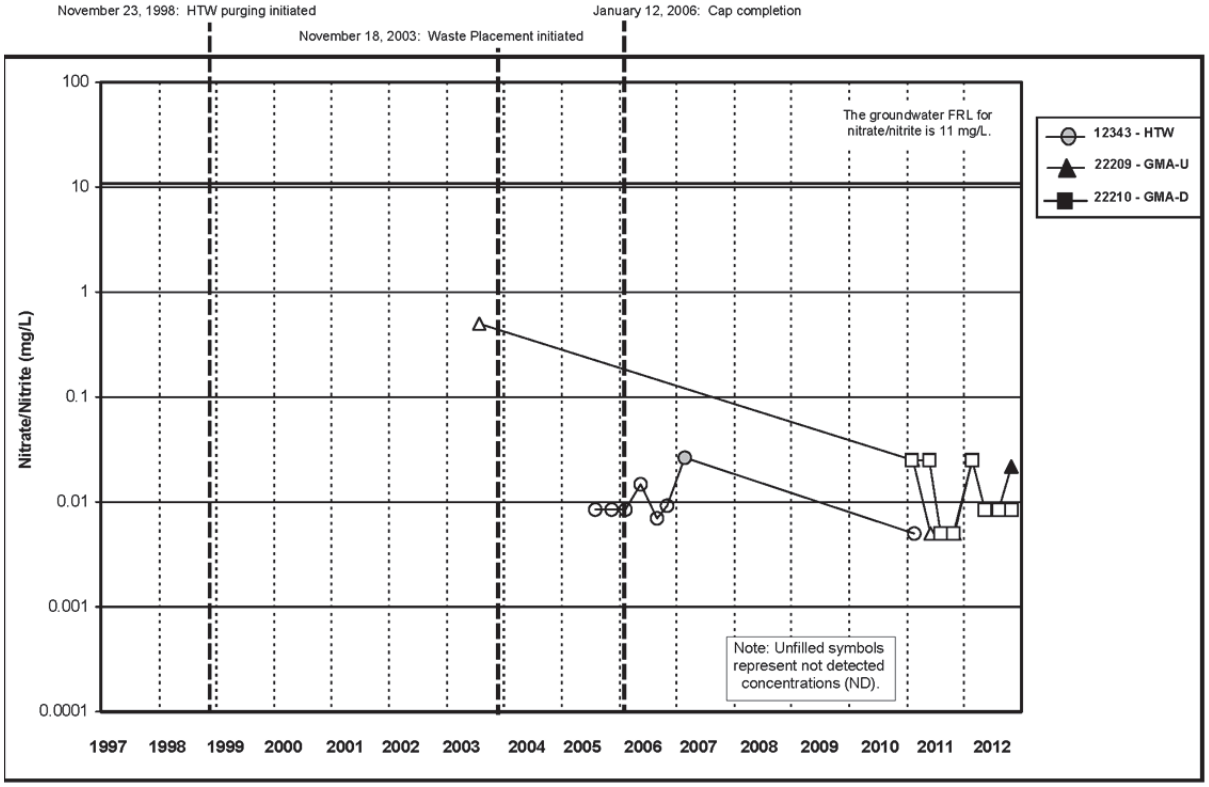


Figure A.5.6–9B. Cell 6 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

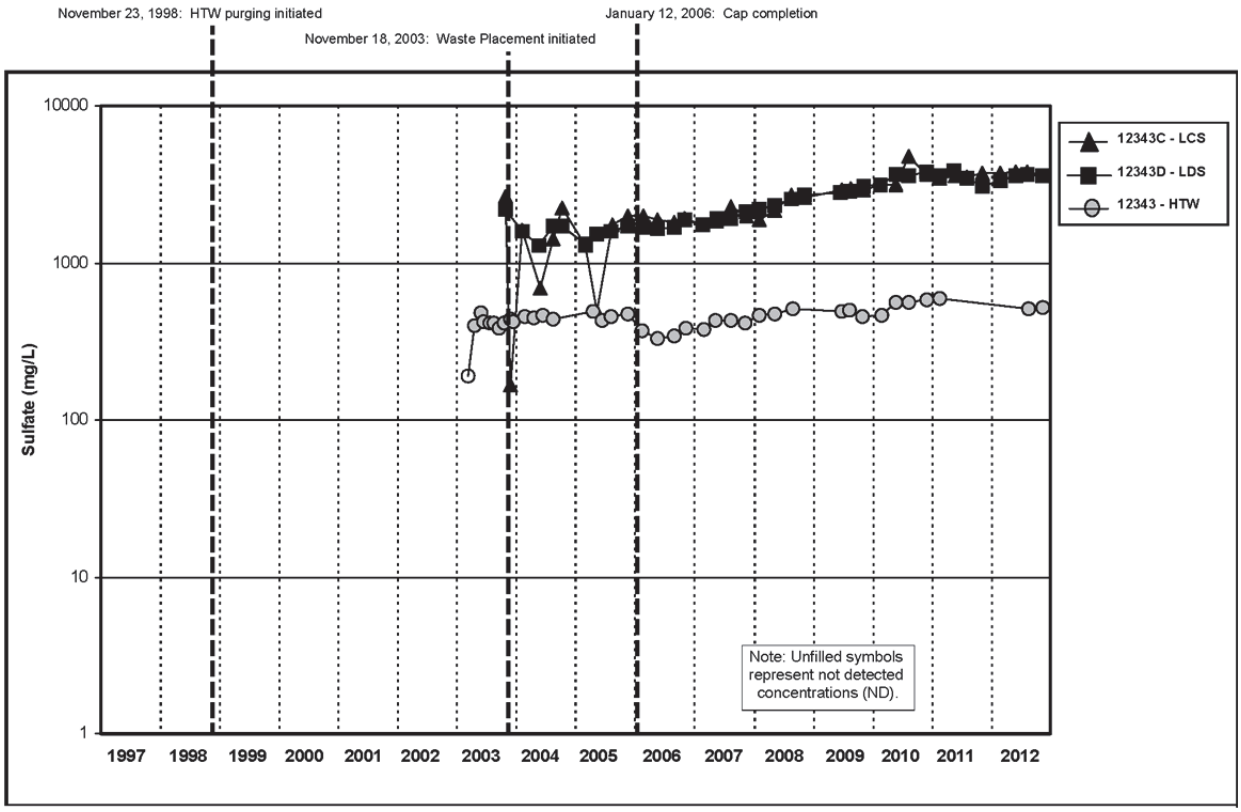


Figure A.5.6–10A. Cell 6 Sulfate Concentration vs. Time Plot for LCS, LDS, and HTW

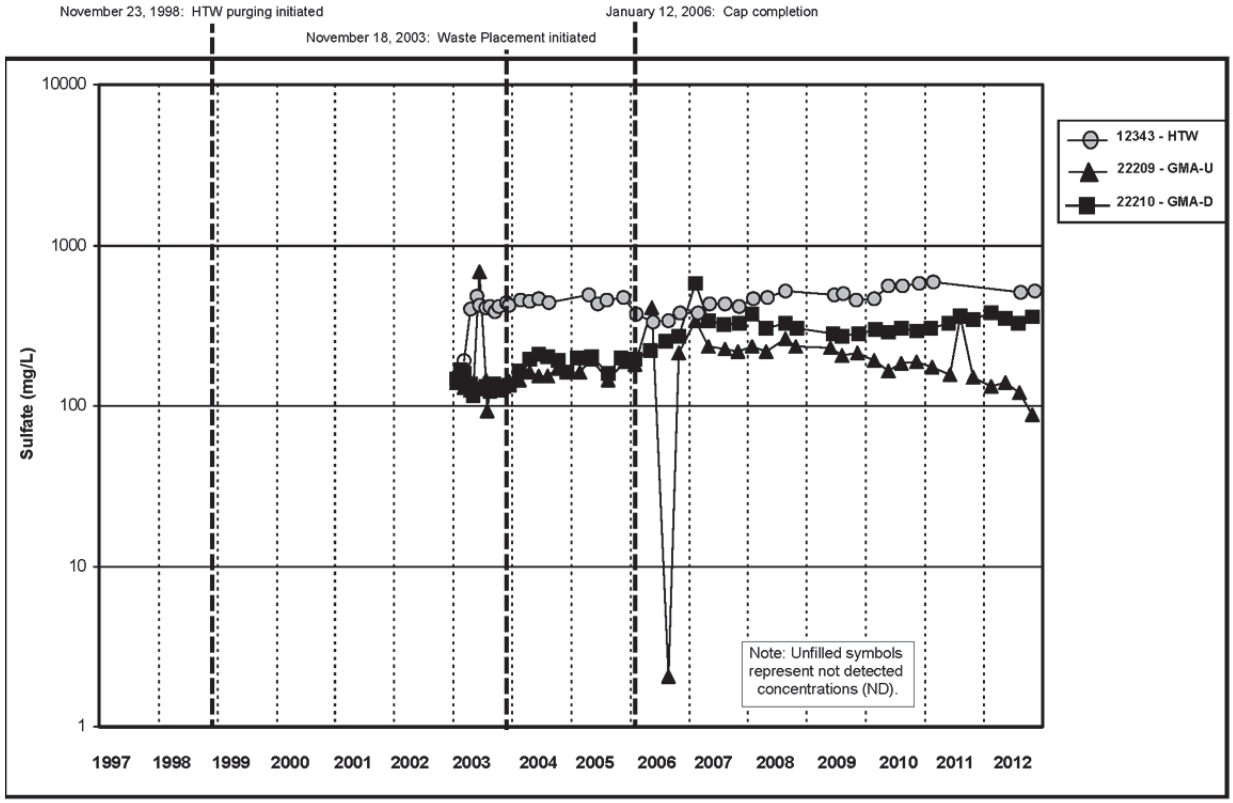


Figure A.5.6–10B. Cell 6 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

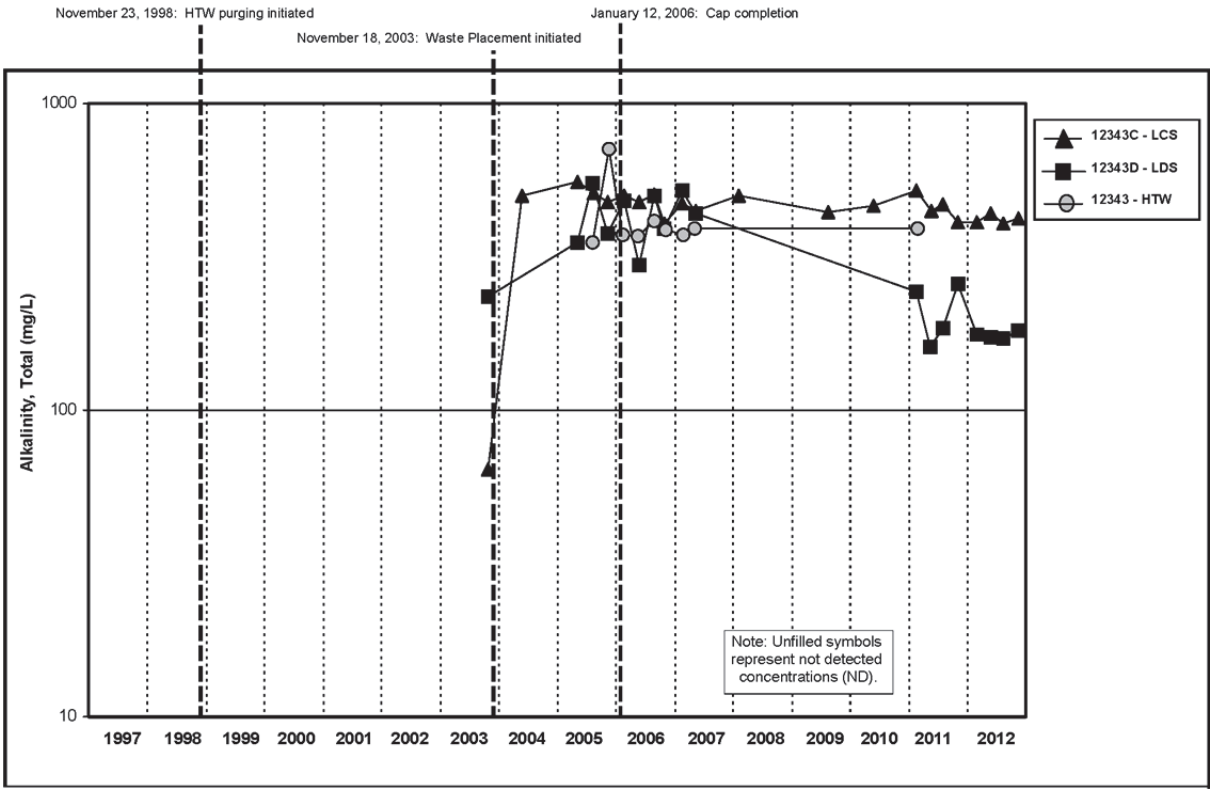


Figure A.5.6–11A. Cell 6 Alkalinity, Total Concentration vs. Time Plot for LCS, LDS, and HTW

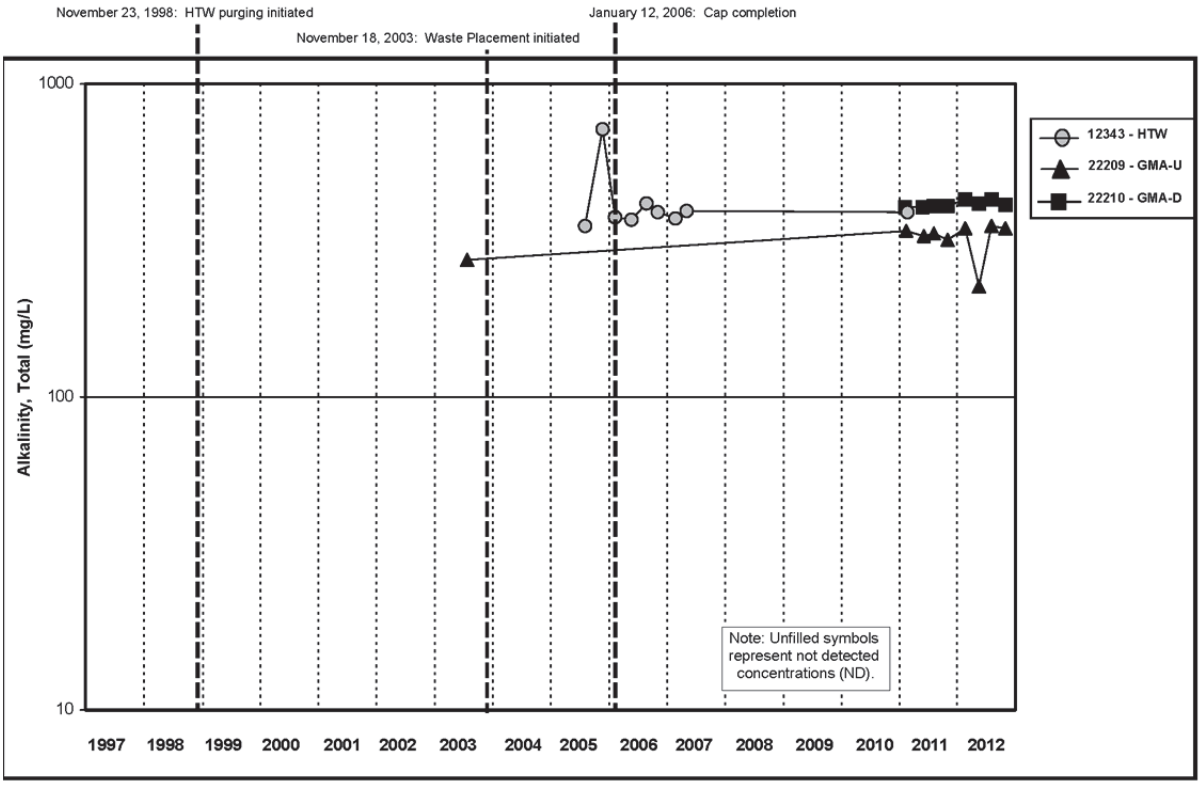


Figure A.5.6–11B. Cell 6 Alkalinity, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

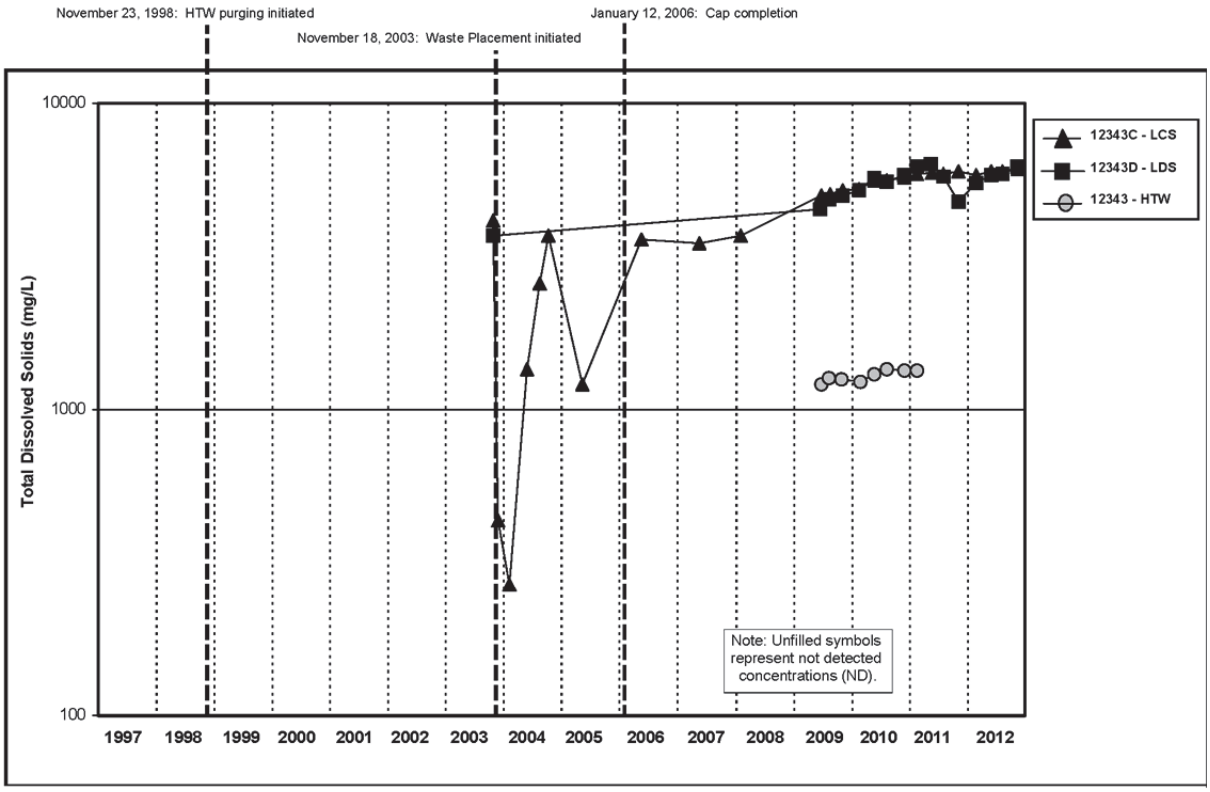


Figure A.5.6–12A. Cell 6 Total Dissolved Solids Concentration vs. Time Plot for LCS, LDS, and HTW

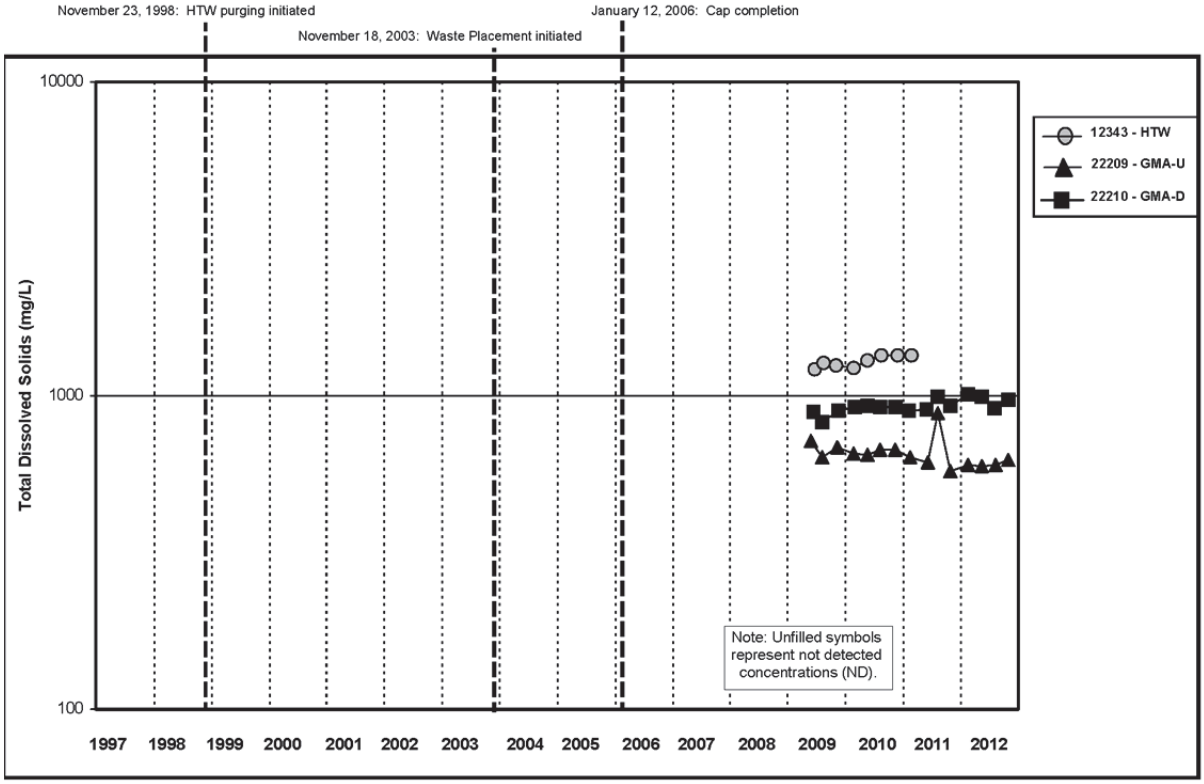


Figure A.5.6–12B. Cell 6 Total Dissolved Solids Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

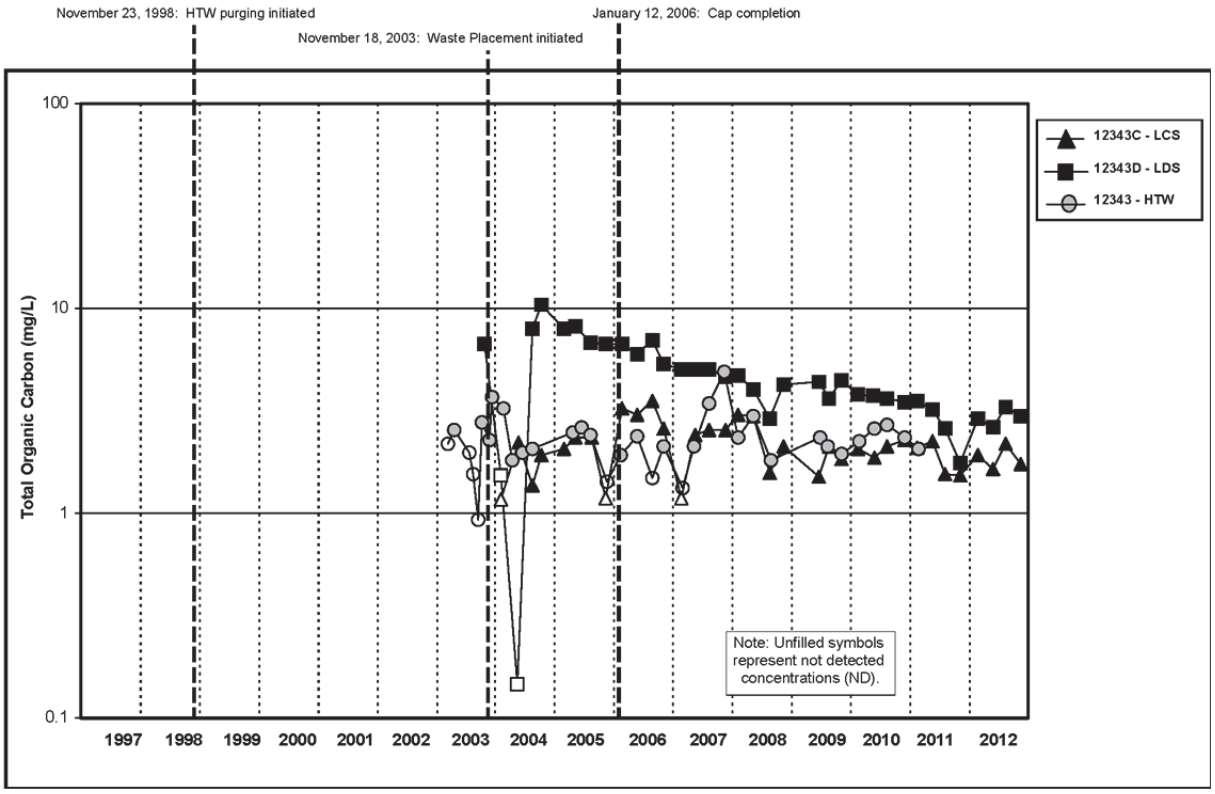


Figure A.5.6–13A. Cell 6 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, and HTW

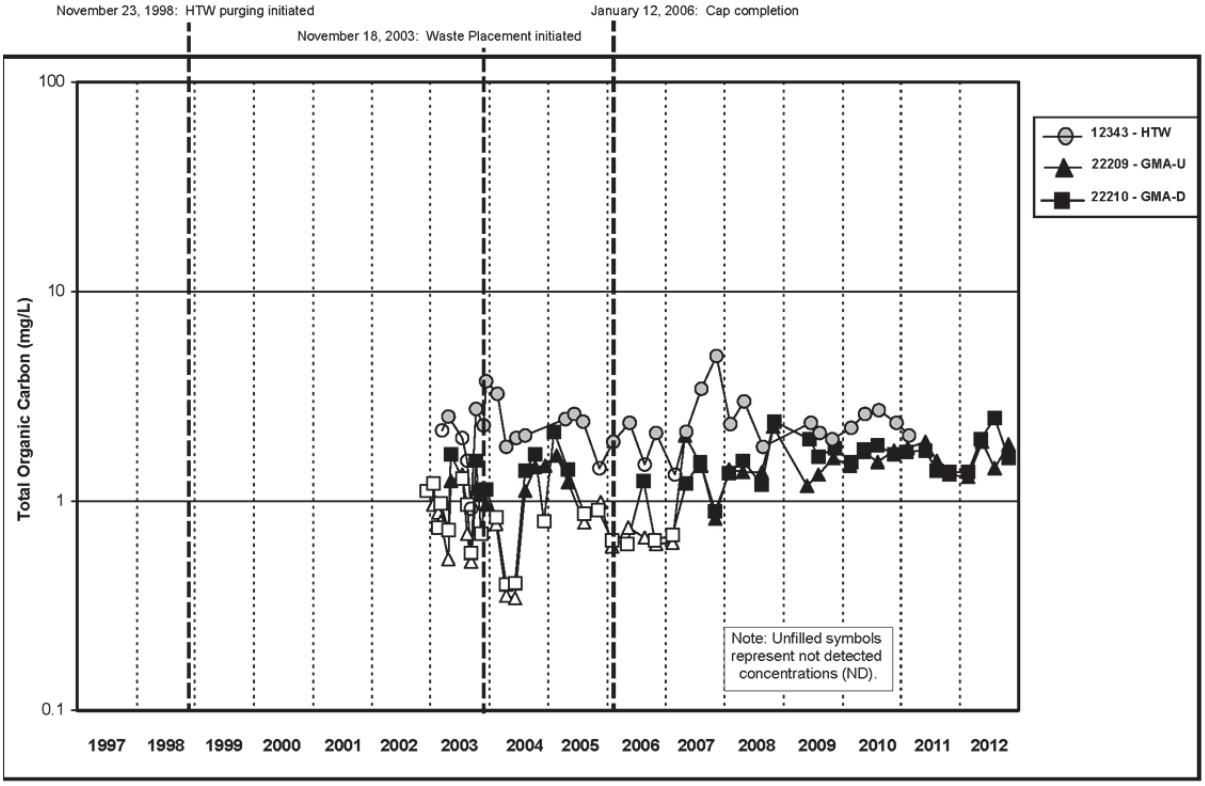


Figure A.5.6–13B. Cell 6 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

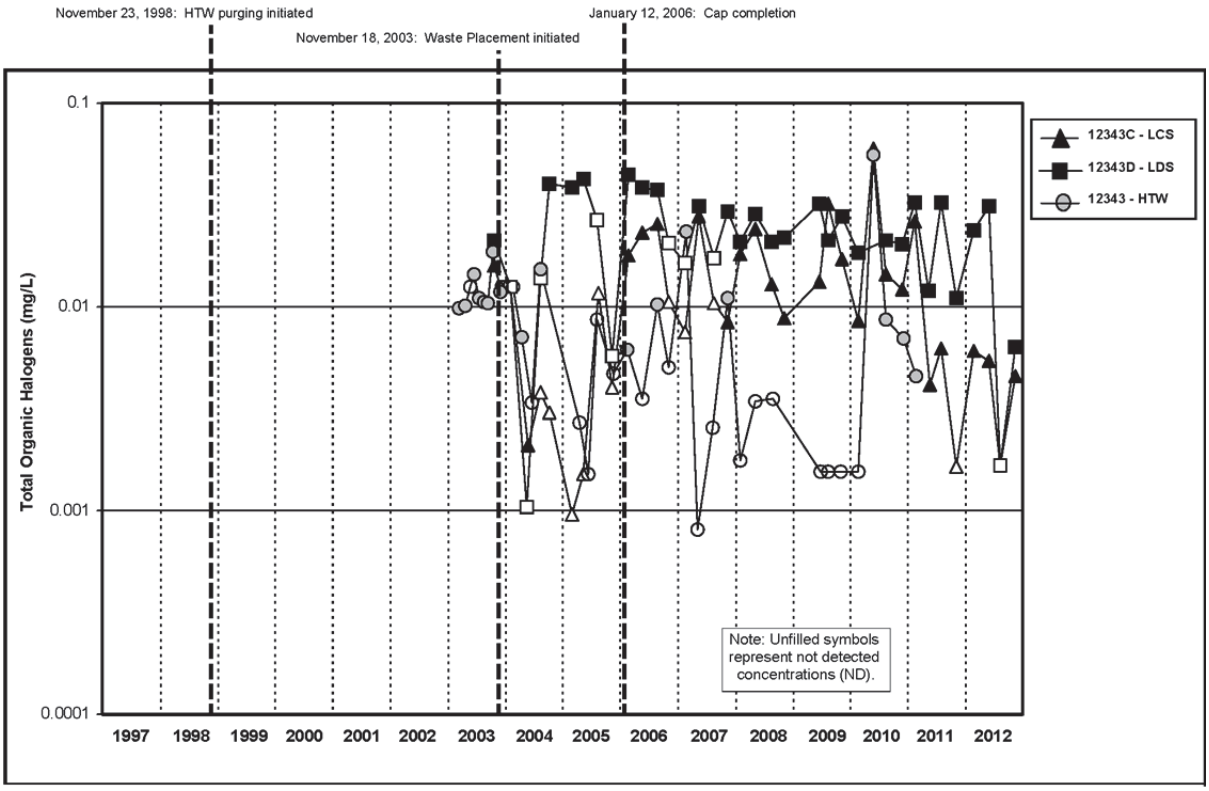


Figure A.5.6–14A. Cell 6 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, and HTW

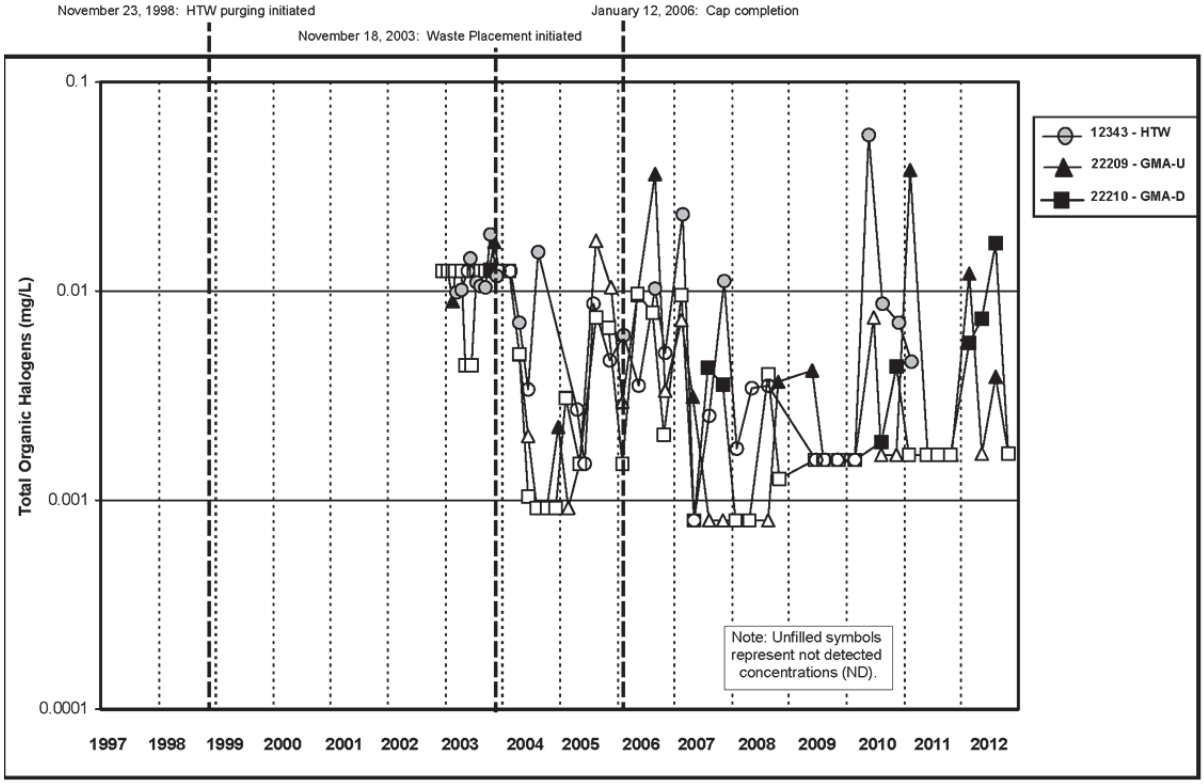


Figure A.5.6–14B. Cell 6 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

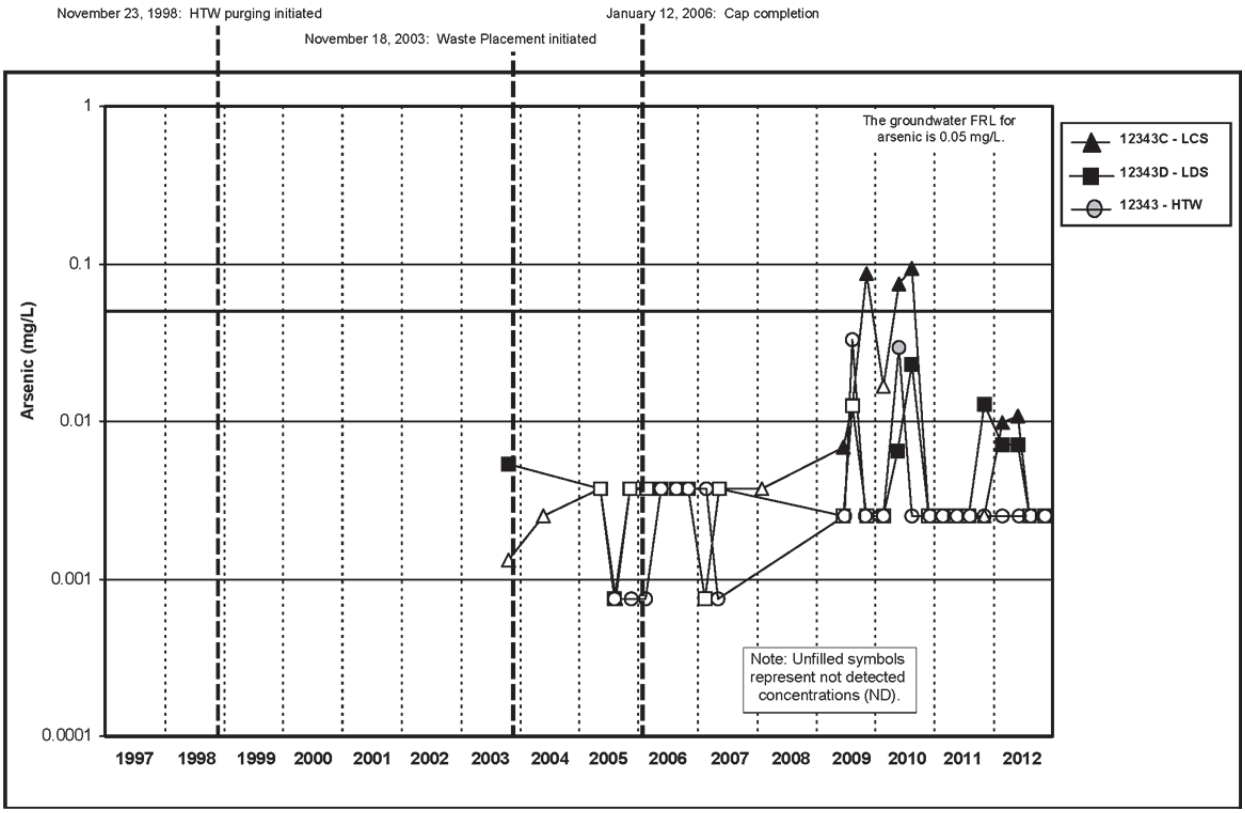


Figure A.5.6–15A. Cell 6 Arsenic Concentration vs. Time Plot for LCS, LDS, and HTW

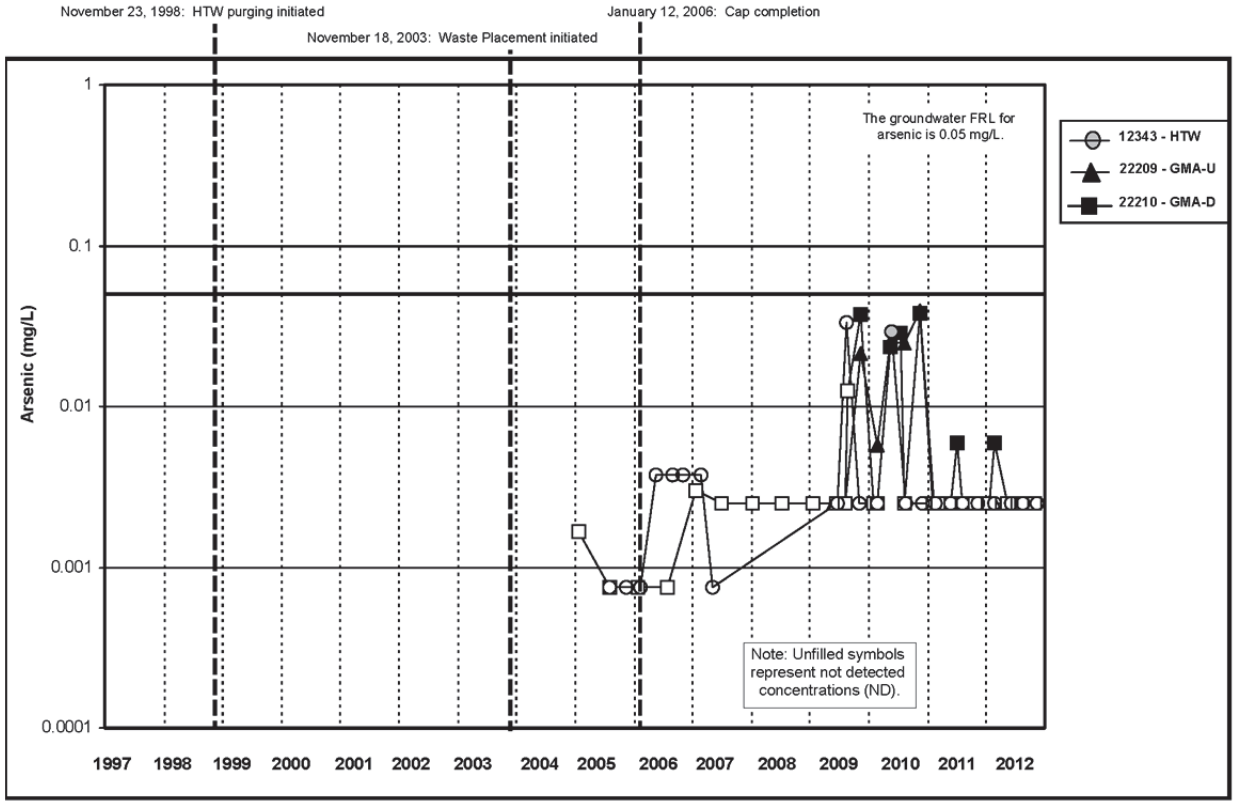


Figure A.5.6–15B. Cell 6 Arsenic Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

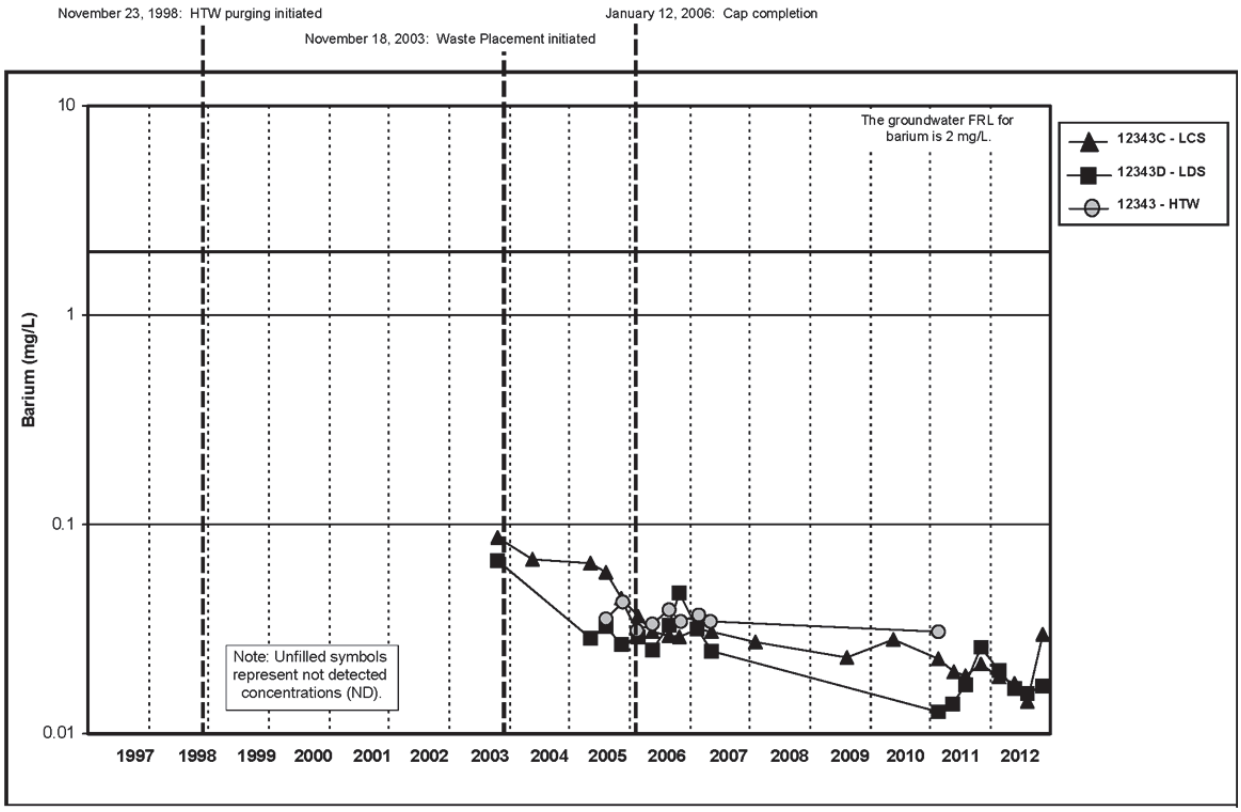


Figure A.5.6–16A. Cell 6 Barium Concentration vs. Time Plot for LCS, LDS, and HTW

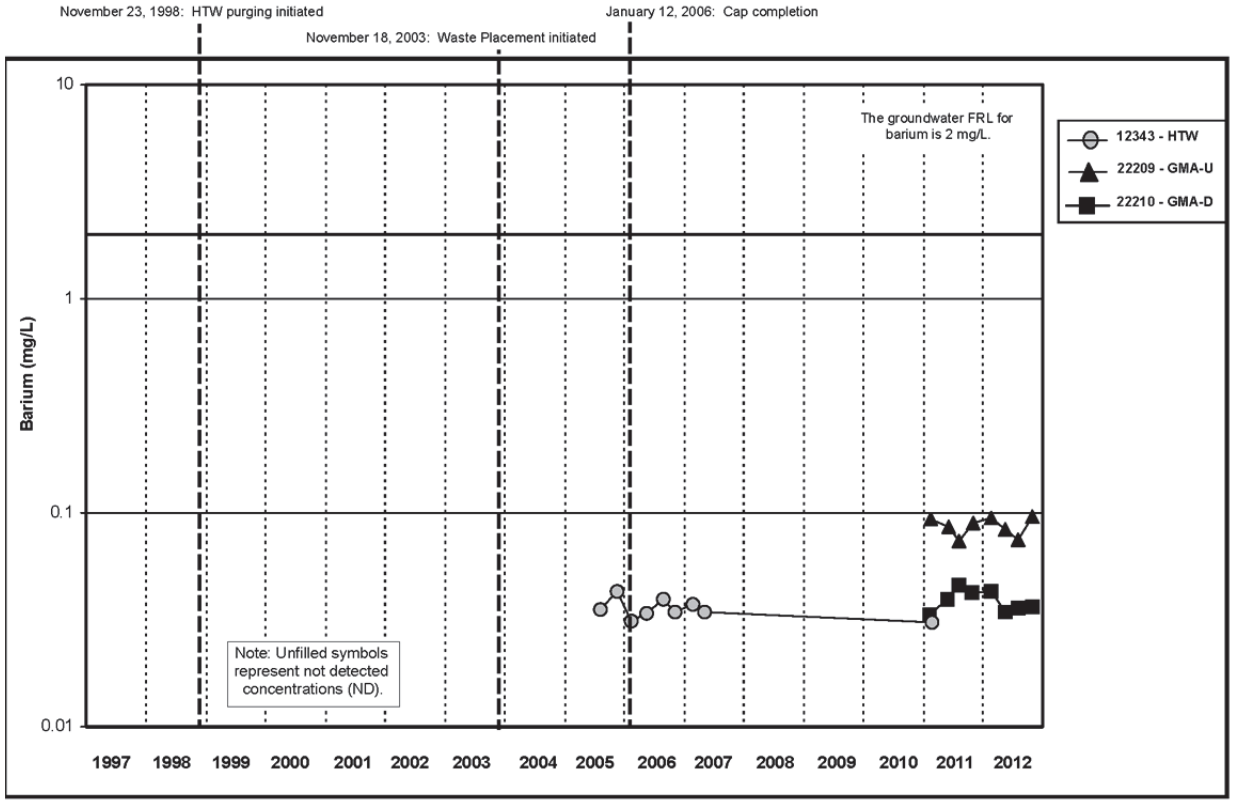


Figure A.5.6–16B. Cell 6 Barium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

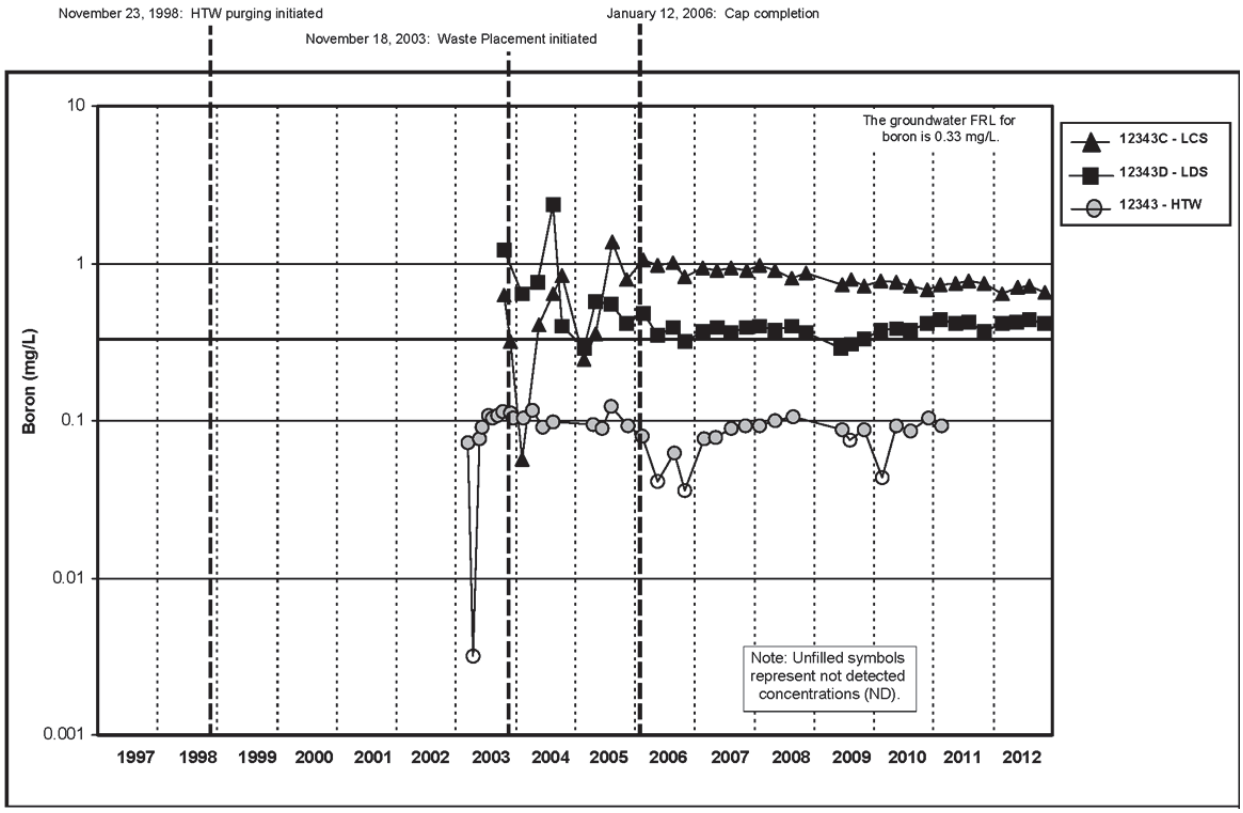


Figure A.5.6–17A. Cell 6 Boron Concentration vs. Time Plot for LCS, LDS, and HTW

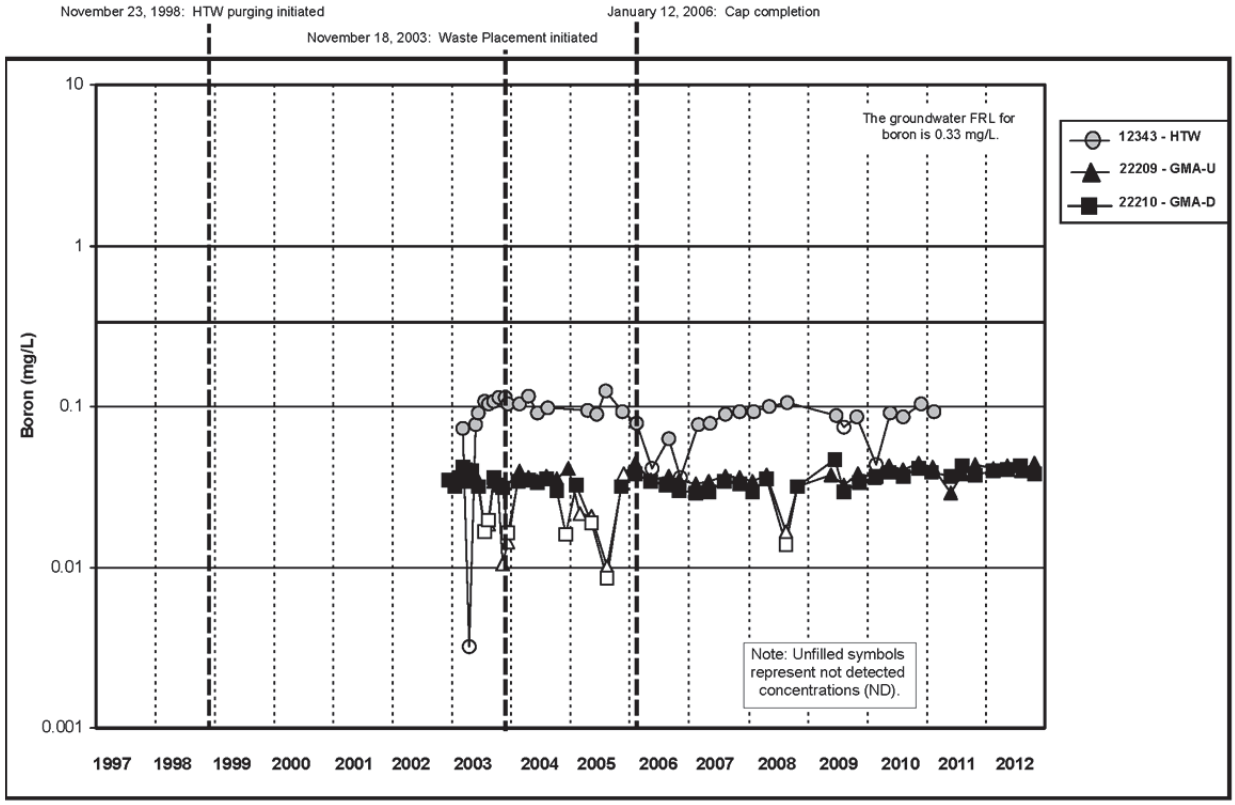


Figure A.5.6–17B. Cell 6 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

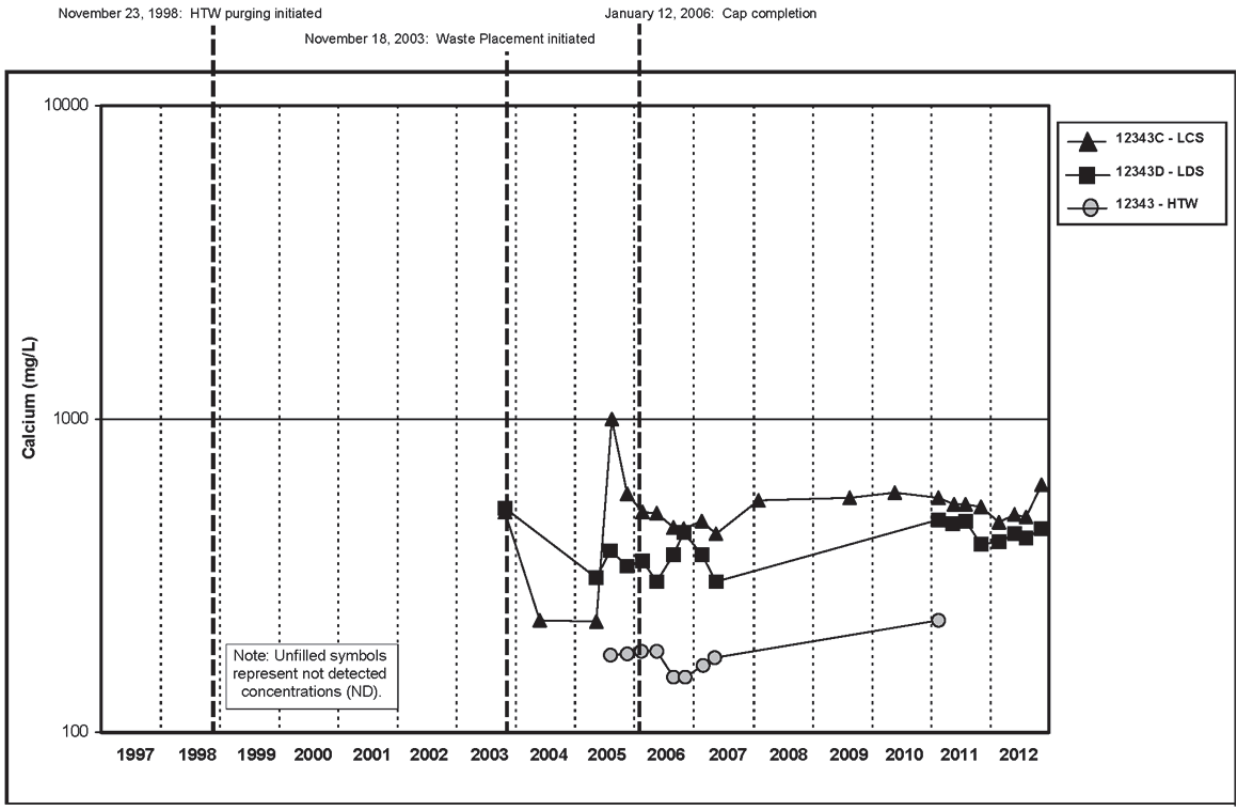


Figure A.5.6–18A. Cell 6 Calcium Concentration vs. Time Plot for LCS, LDS, and HTW

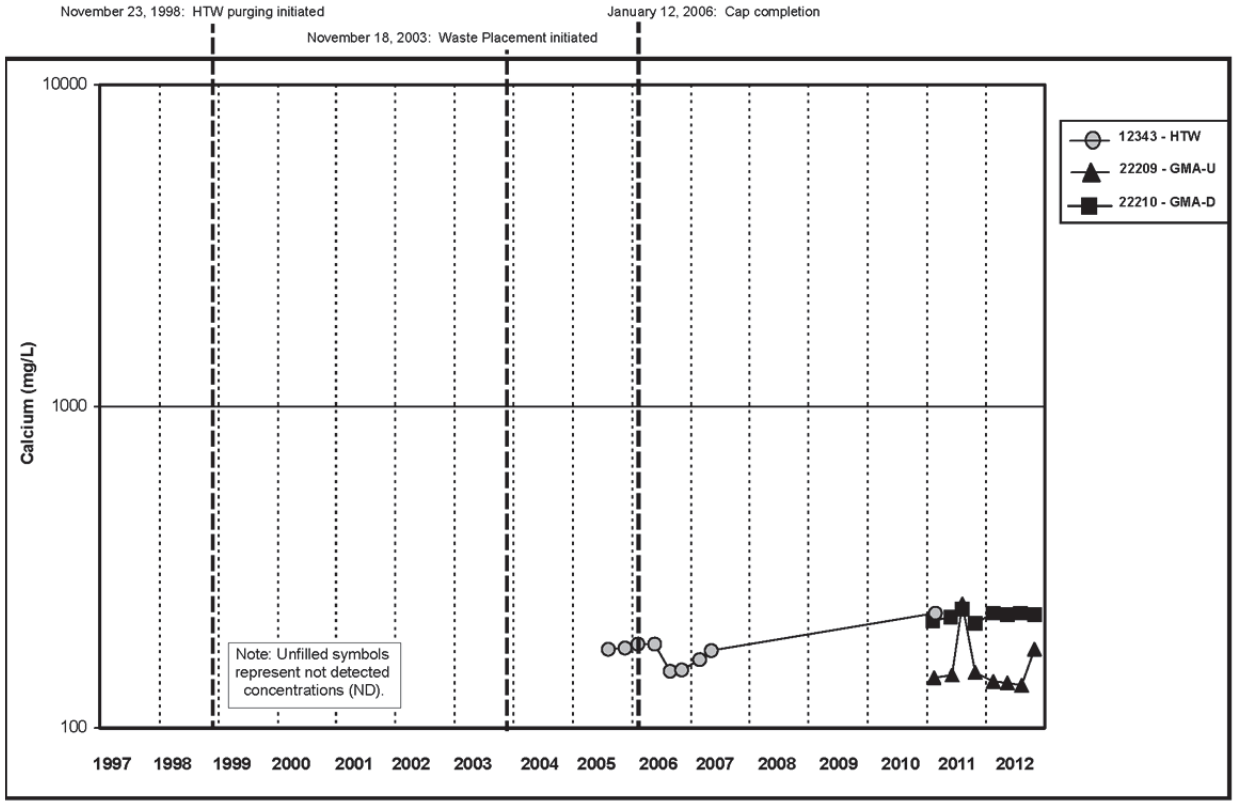


Figure A.5.6–18B. Cell 6 Calcium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

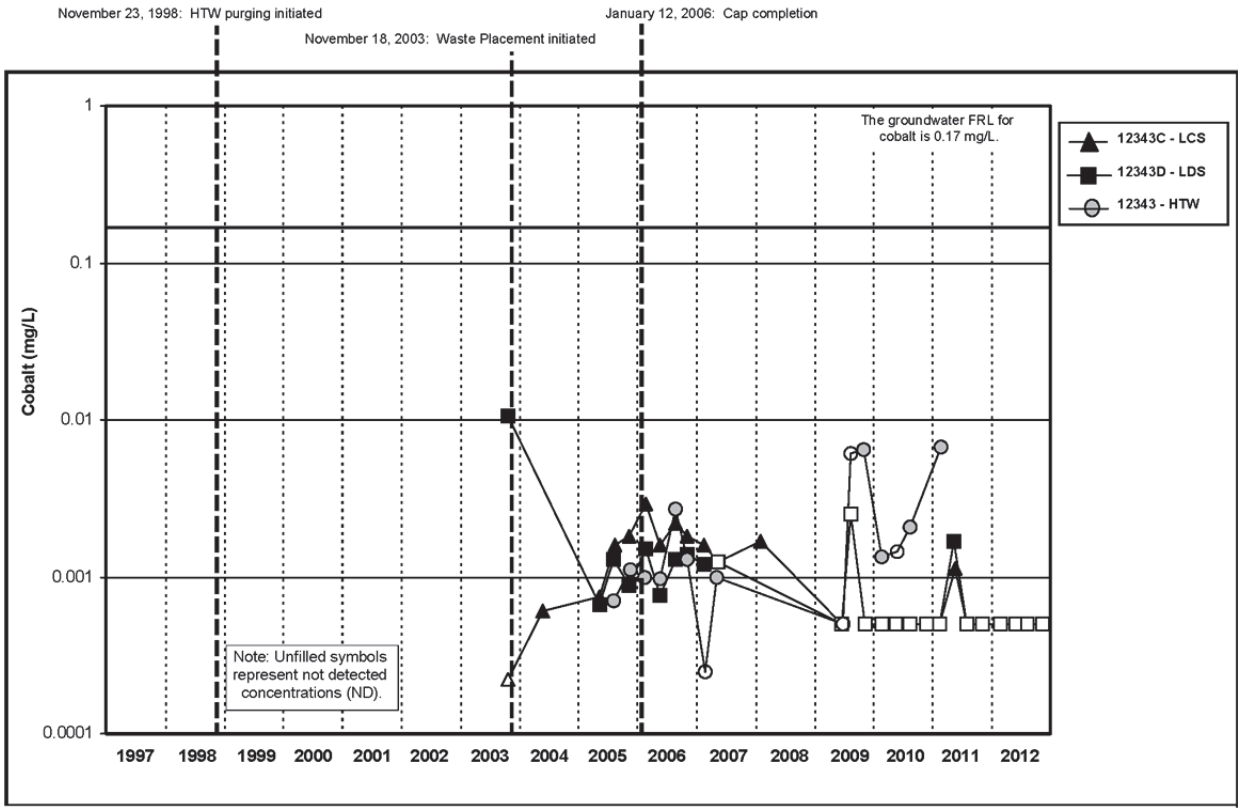


Figure A.5.6–19A. Cell 6 Cobalt Concentration vs. Time Plot for LCS, LDS, and HTW

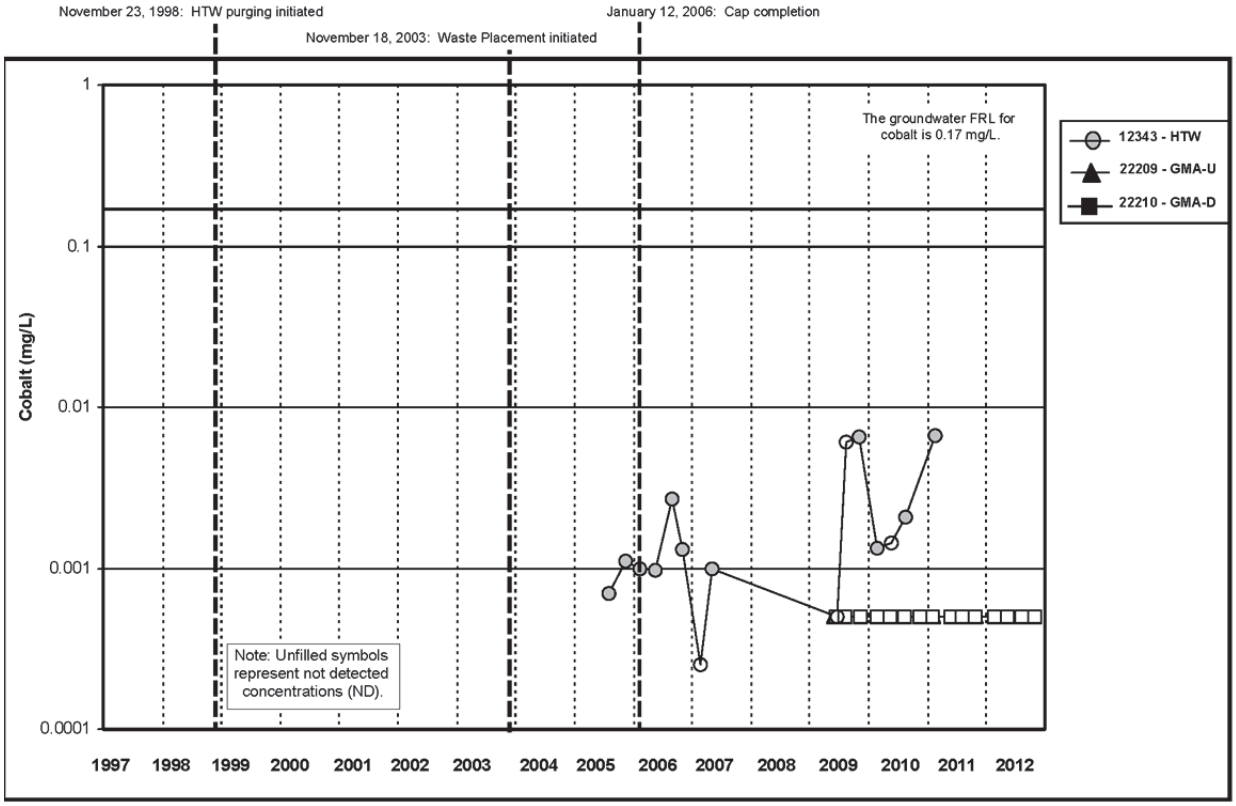


Figure A.5.6–19B. Cell 6 Cobalt Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

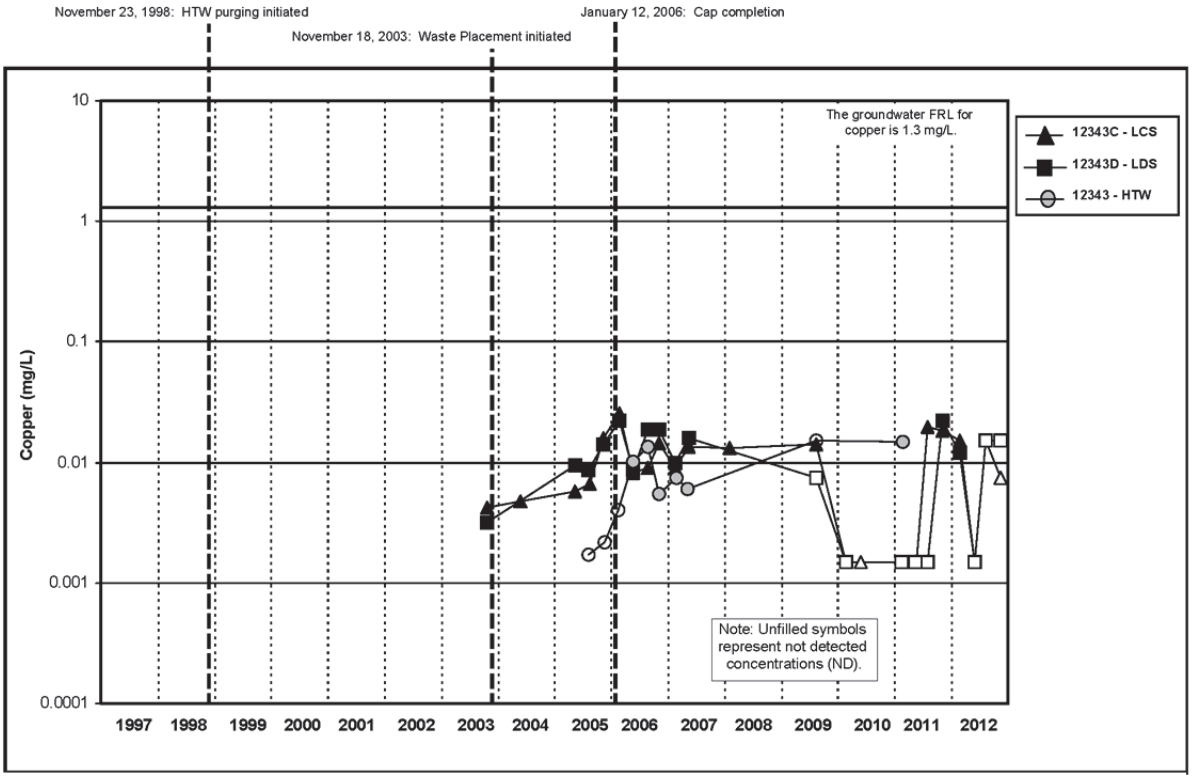


Figure A.5.6–20A. Cell 6 Copper Concentration vs. Time Plot for LCS, LDS, and HTW

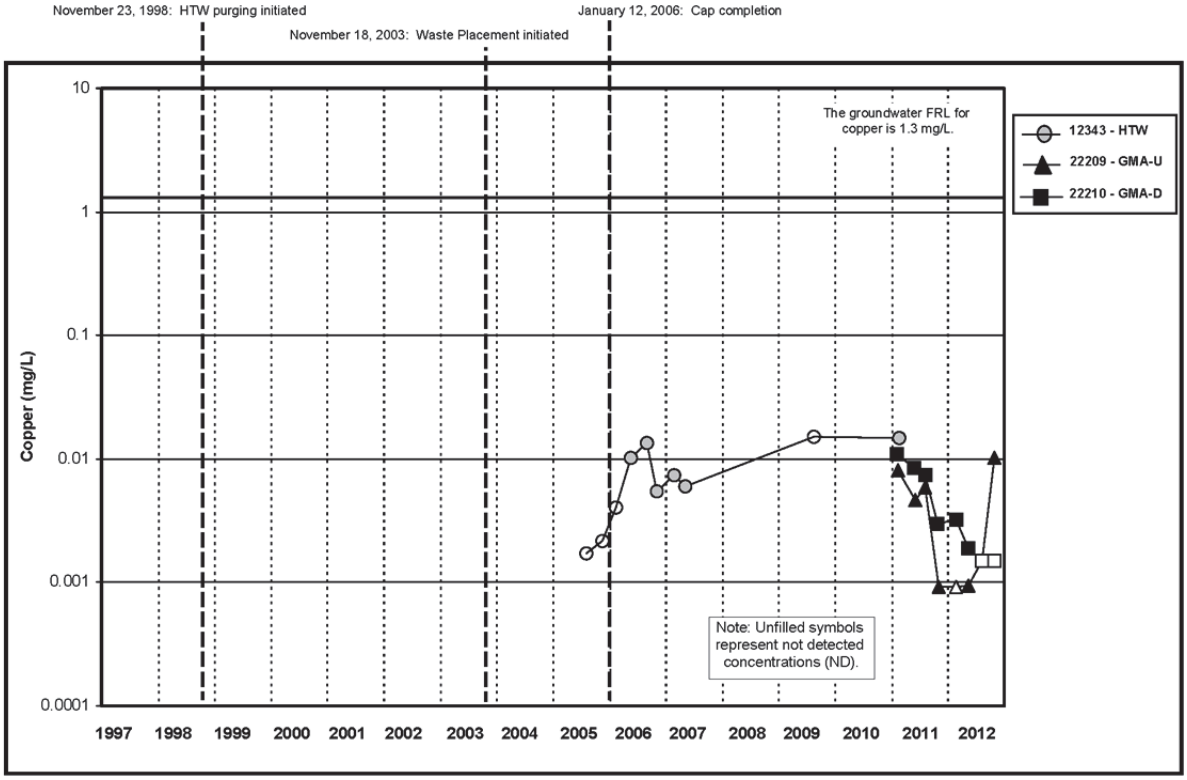


Figure A.5.6–20B. Cell 6 Copper Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

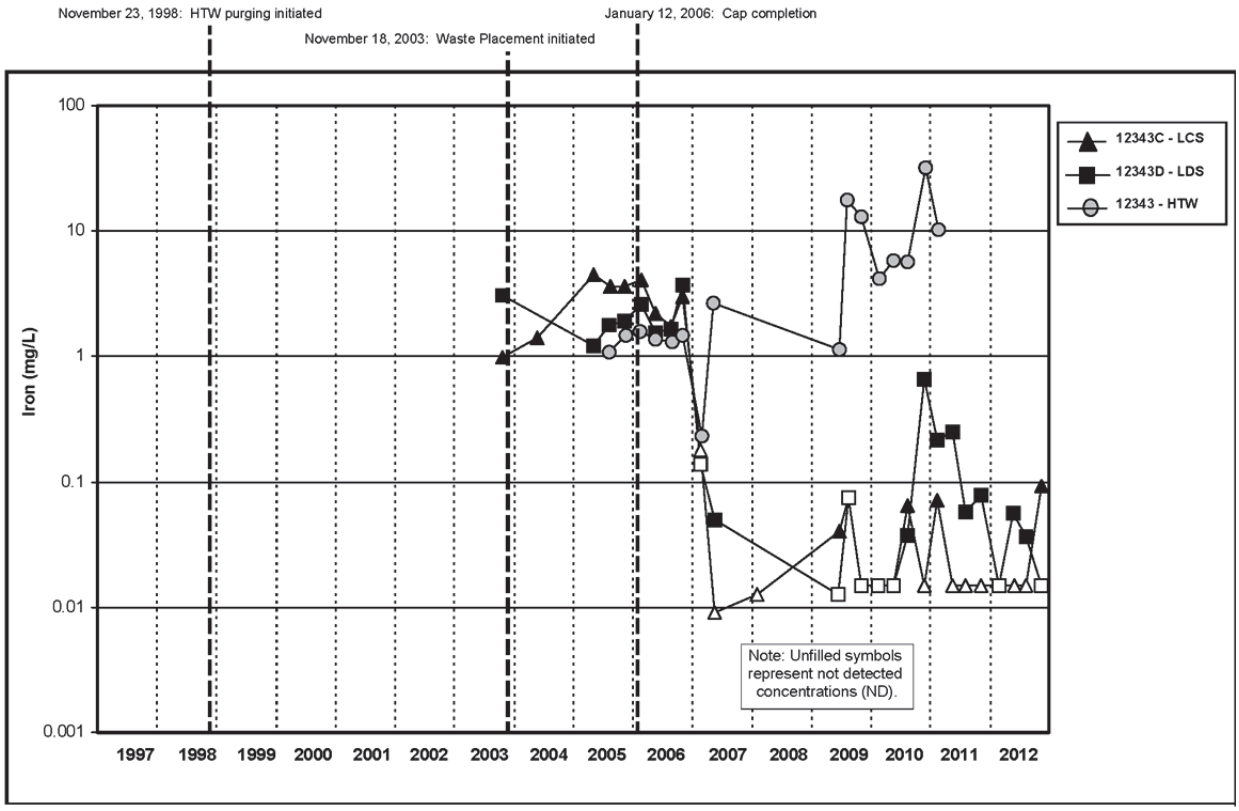


Figure A.5.6–21A. Cell 6 Iron Concentration vs. Time Plot for LCS, LDS, and HTW

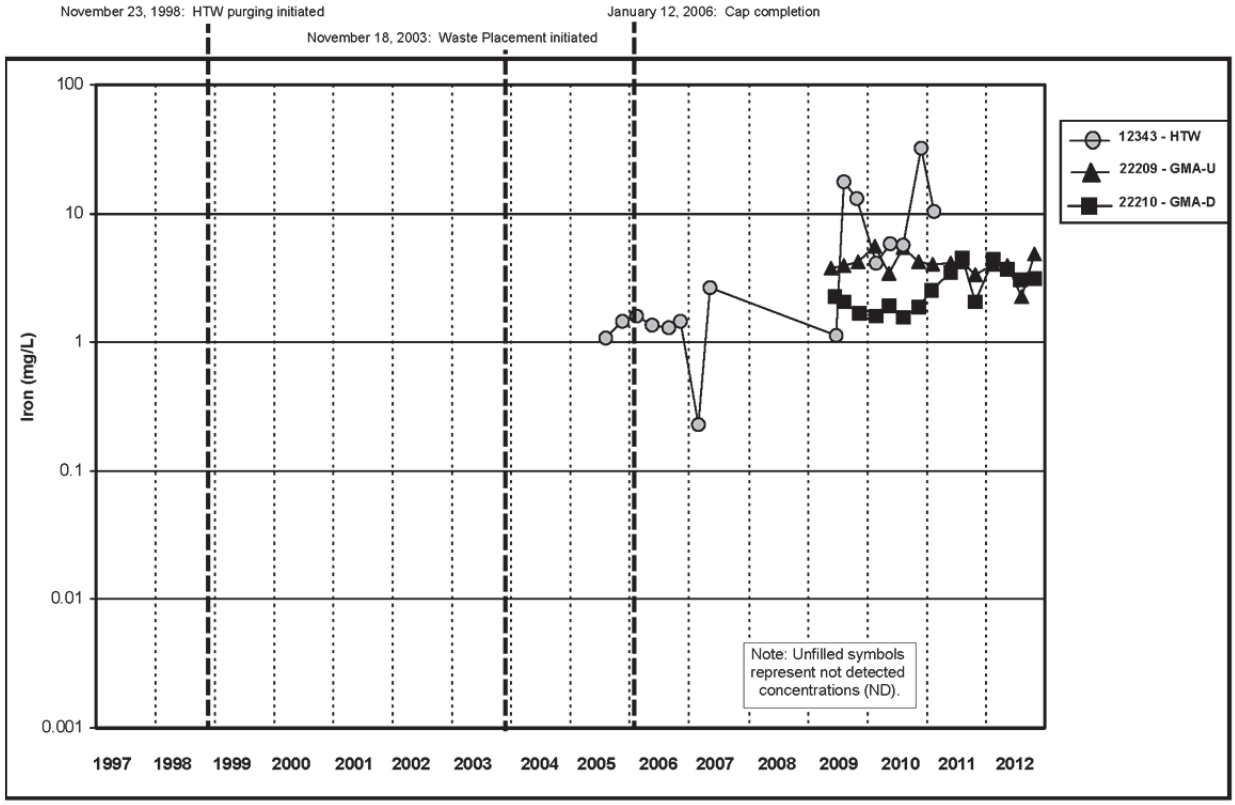


Figure A.5.6–21B. Cell 6 Iron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

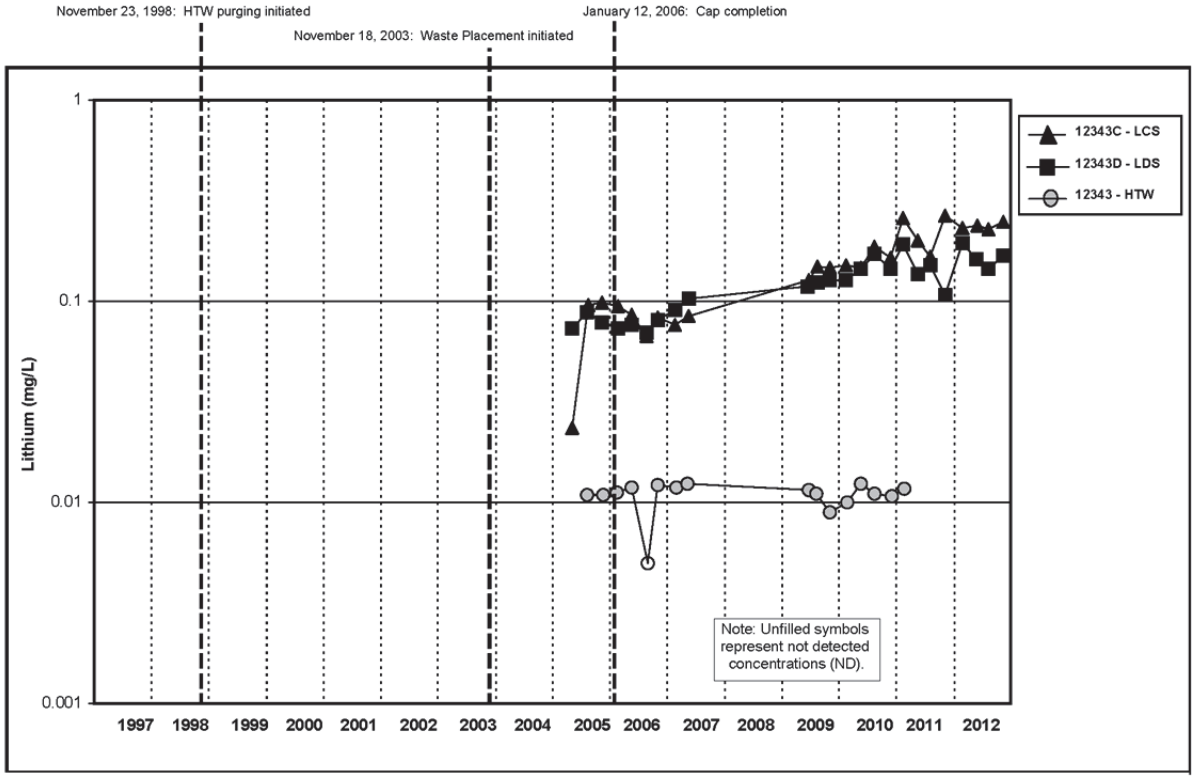


Figure A.5.6–22A. Cell 6 Lithium Concentration vs. Time Plot for LCS, LDS, and HTW

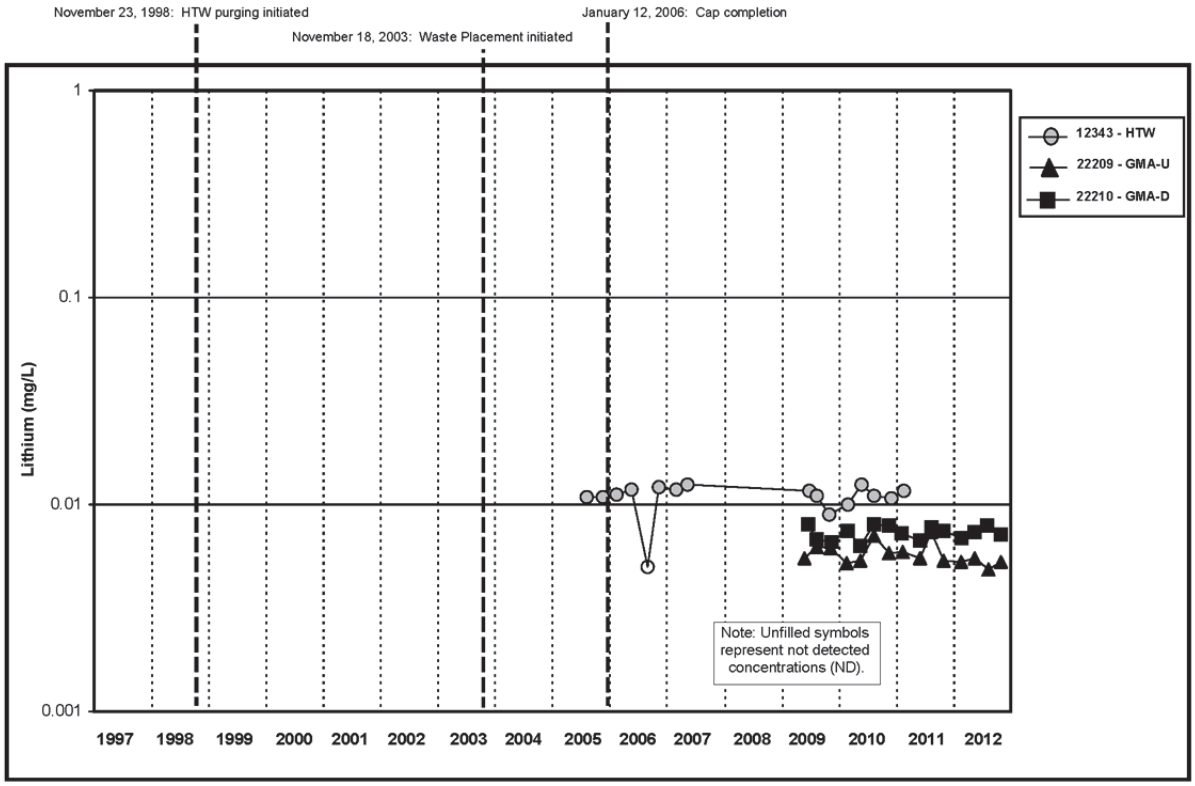


Figure A.5.6–22B. Cell 6 Lithium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

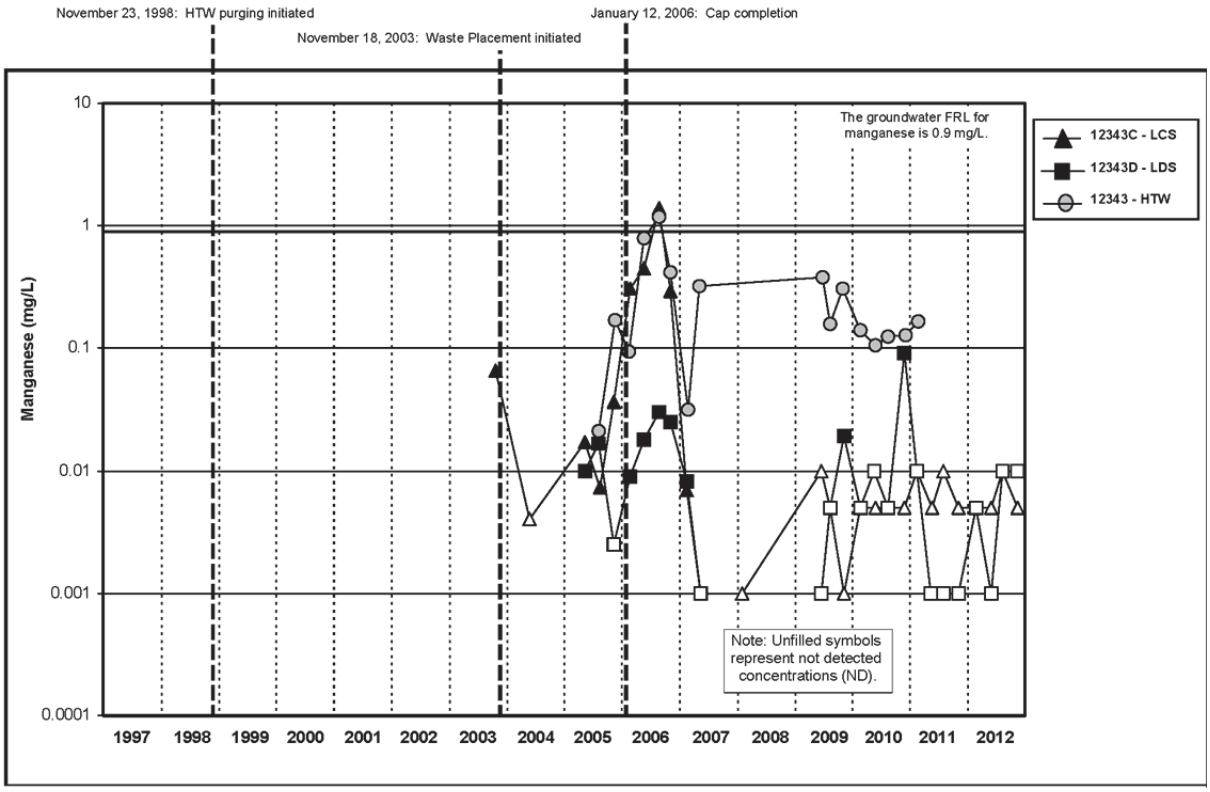


Figure A.5.6–23A. Cell 6 Manganese Concentration vs. Time Plot for LCS, LDS, and HTW

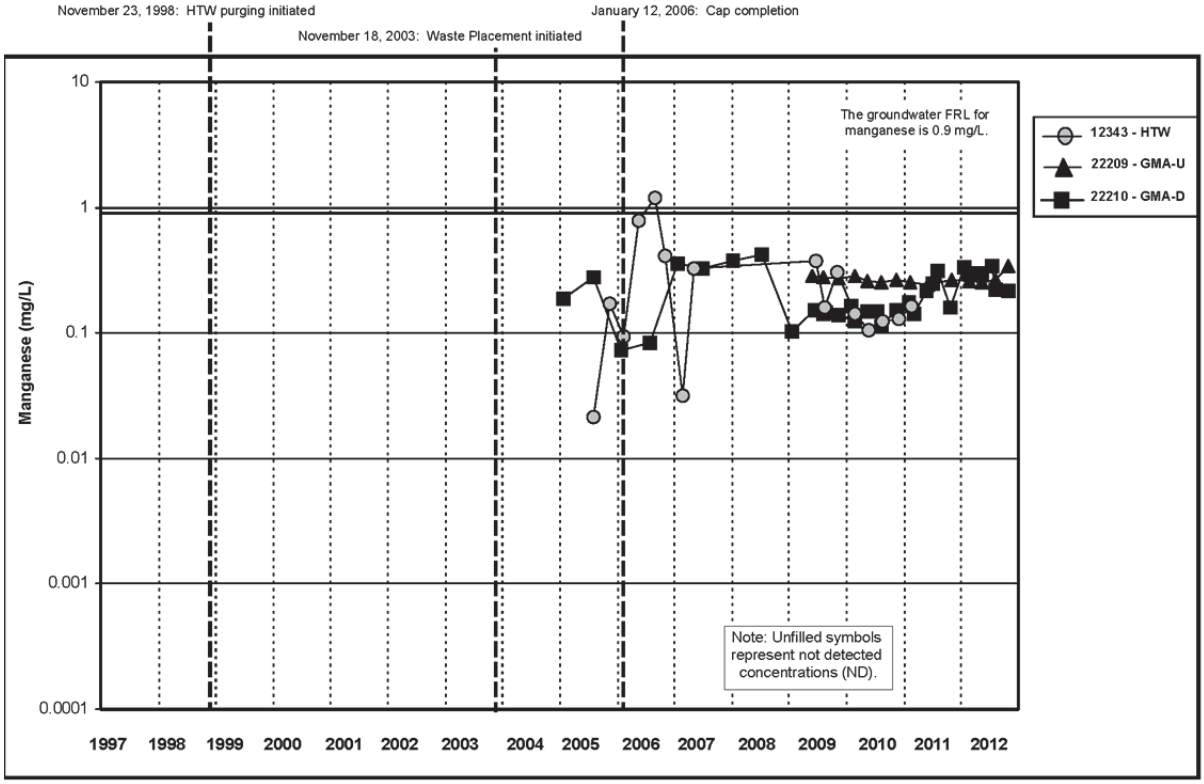


Figure A.5.6–23B. Cell 6 Manganese Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

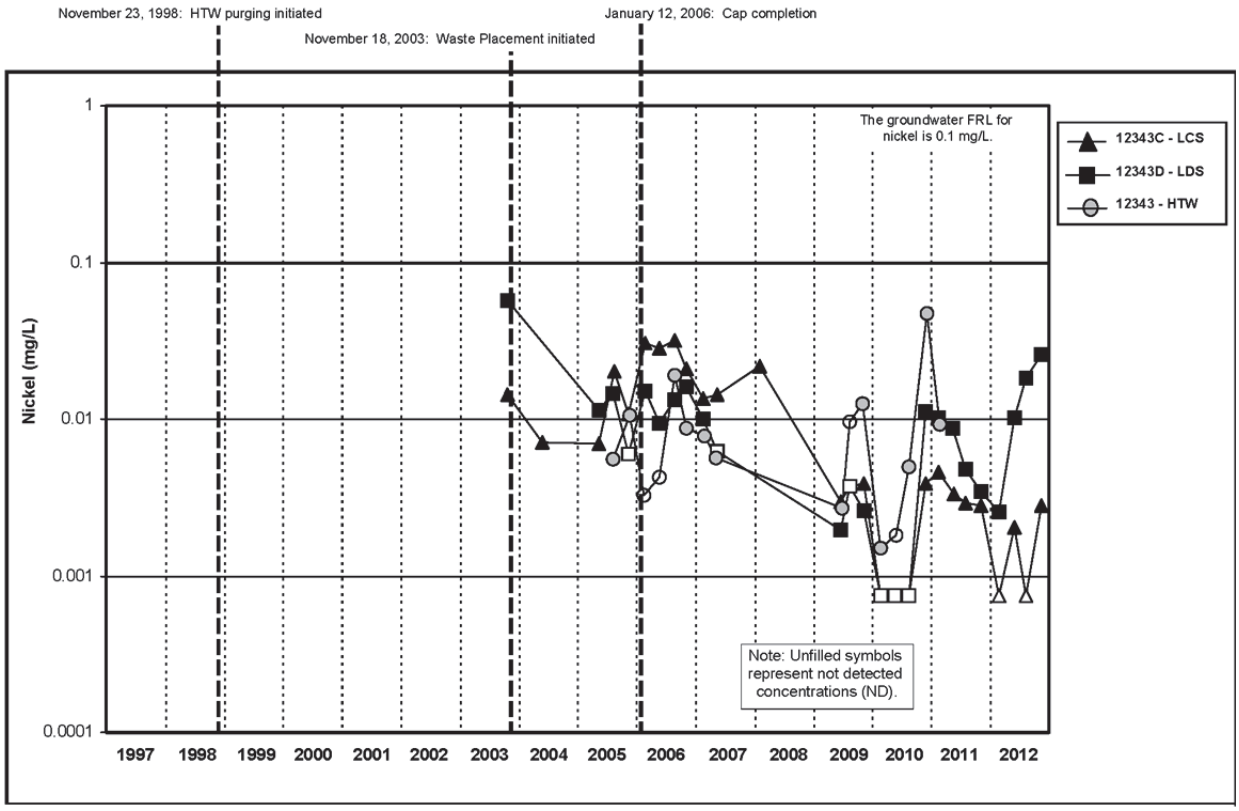


Figure A.5.6–24A. Cell 6 Nickel Concentration vs. Time Plot for LCS, LDS, and HTW

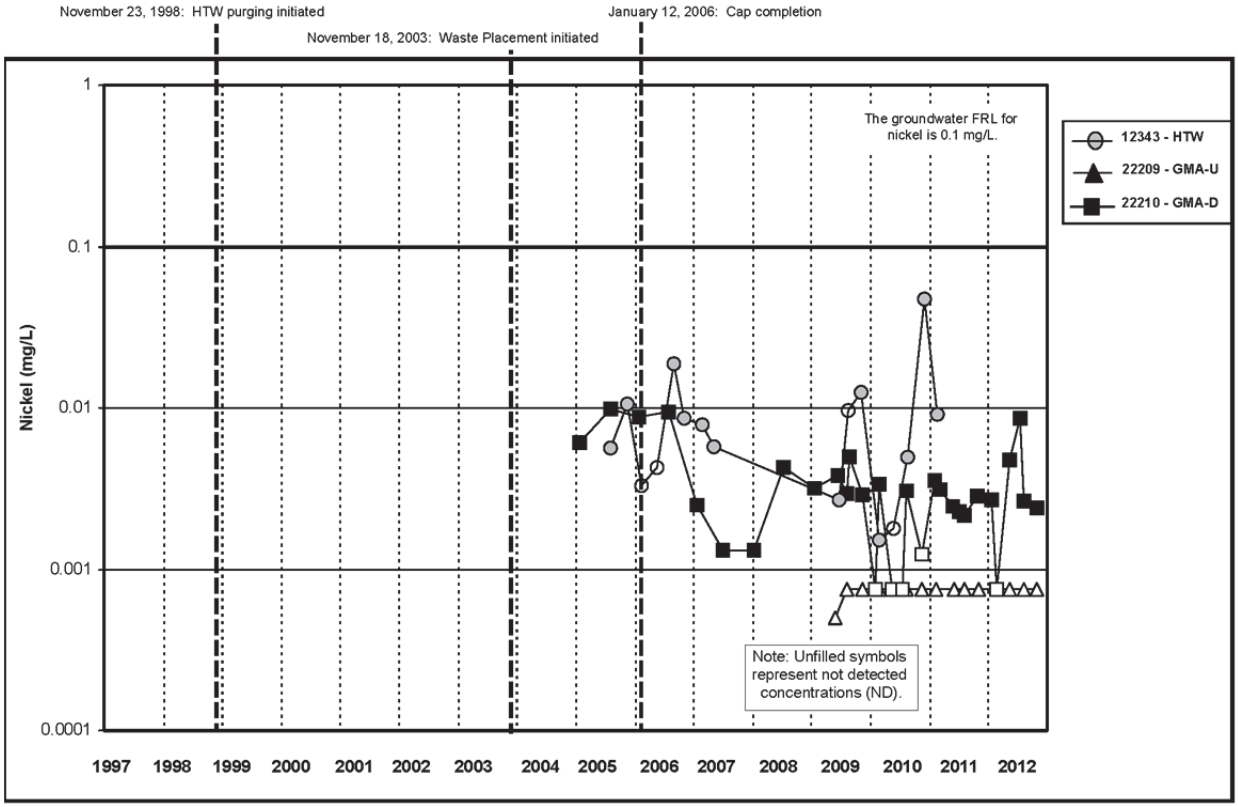


Figure A.5.6–24B. Cell 6 Nickel Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

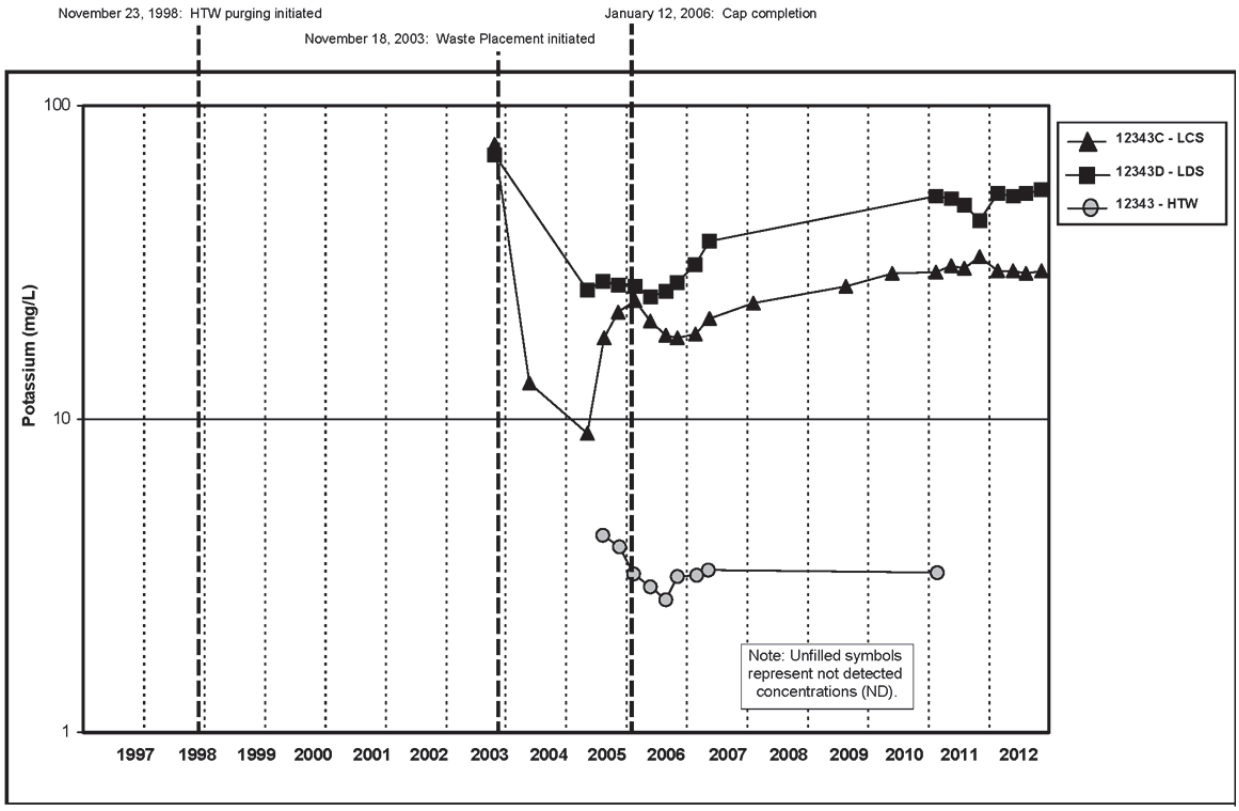


Figure A.5.6–25A. Cell 6 Potassium Concentration vs. Time Plot for LCS, LDS, and HTW

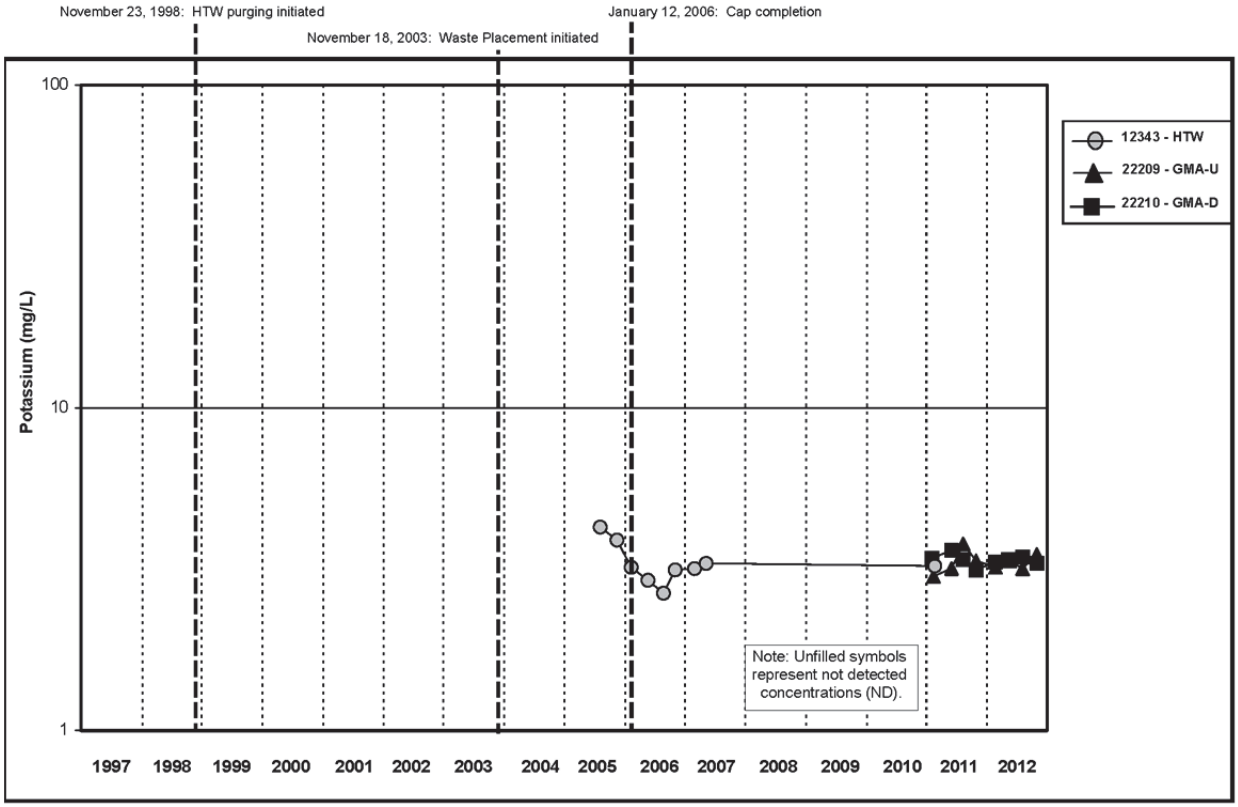


Figure A.5.6–25B. Cell 6 Potassium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

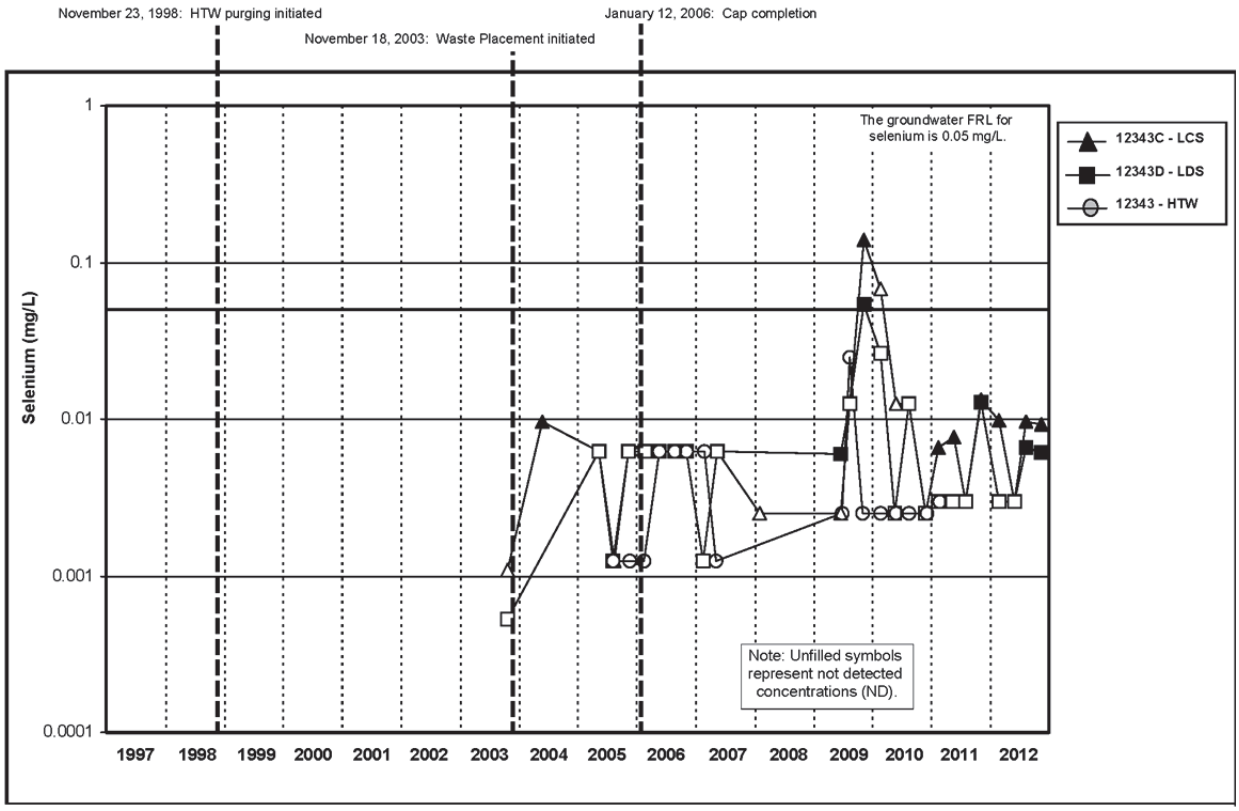


Figure A.5.6–26A. Cell 6 Selenium Concentration vs. Time Plot for LCS, LDS, and HTW

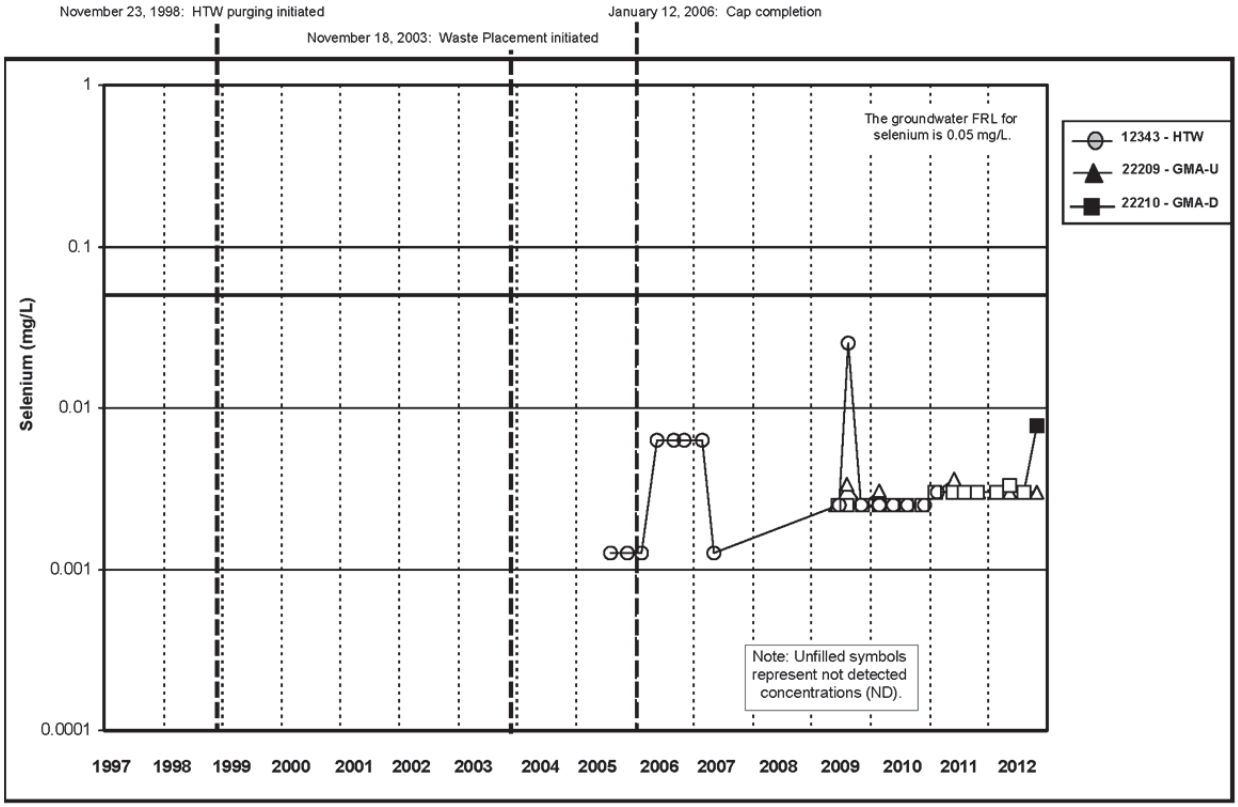


Figure A.5.6–26B. Cell 6 Selenium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

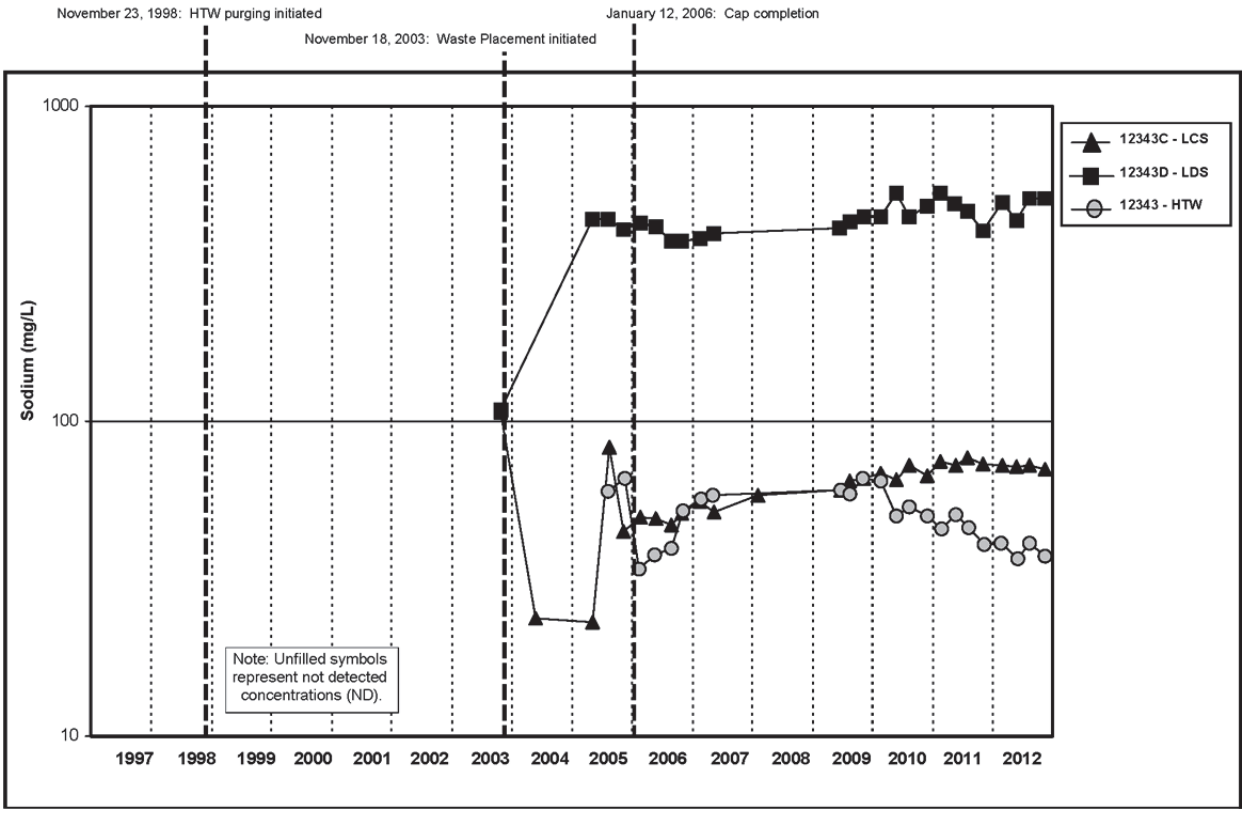


Figure A.5.6–27A. Cell 6 Sodium Concentration vs. Time Plot for LCS, LDS, and HTW

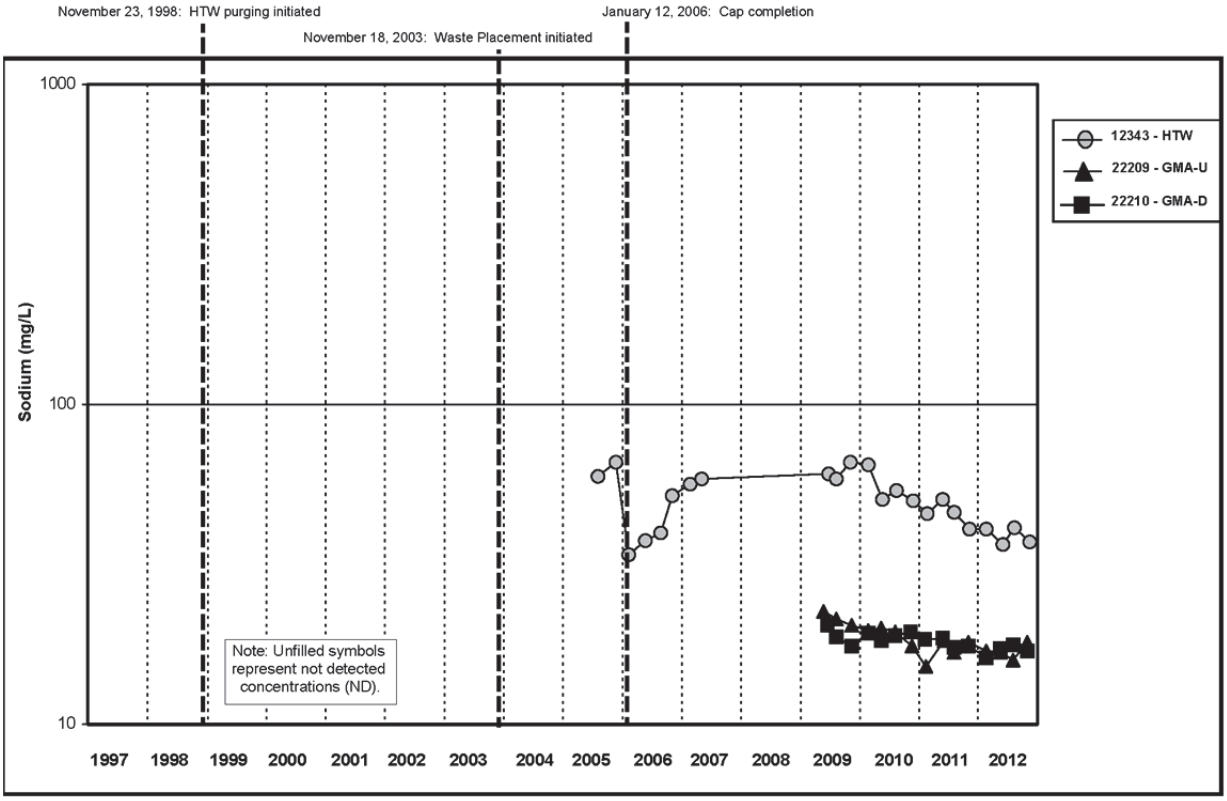


Figure A.5.6–27B. Cell 6 Sodium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

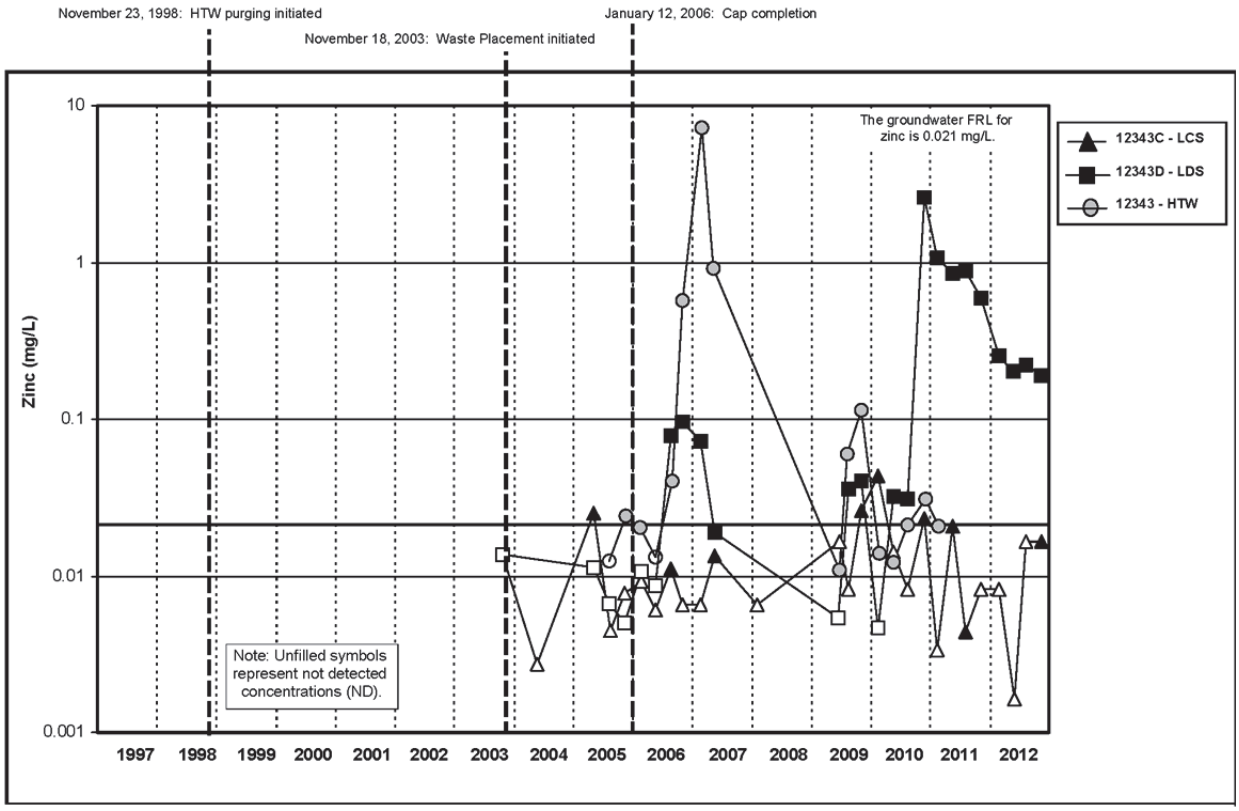


Figure A.5.6–28A. Cell 6 Zinc Concentration vs. Time Plot for LCS, LDS, and HTW

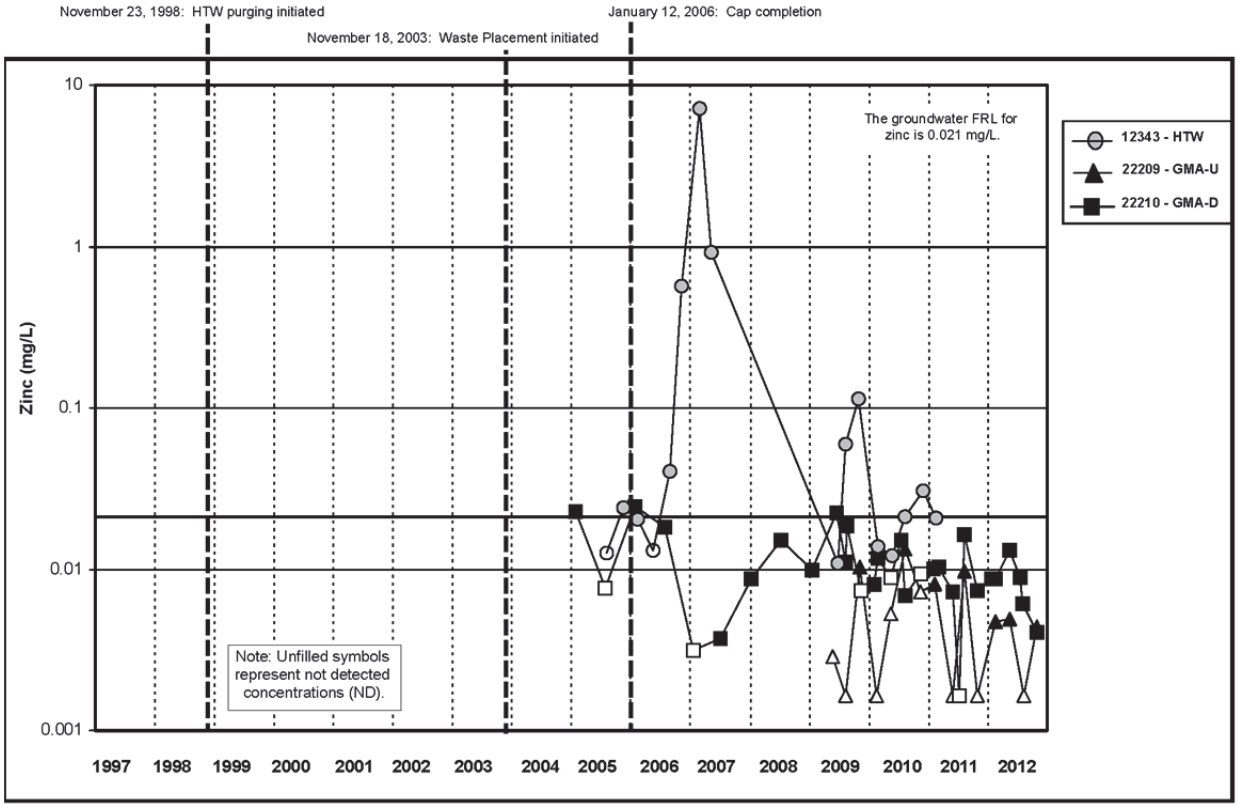


Figure A.5.6–28B. Cell 6 Zinc Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

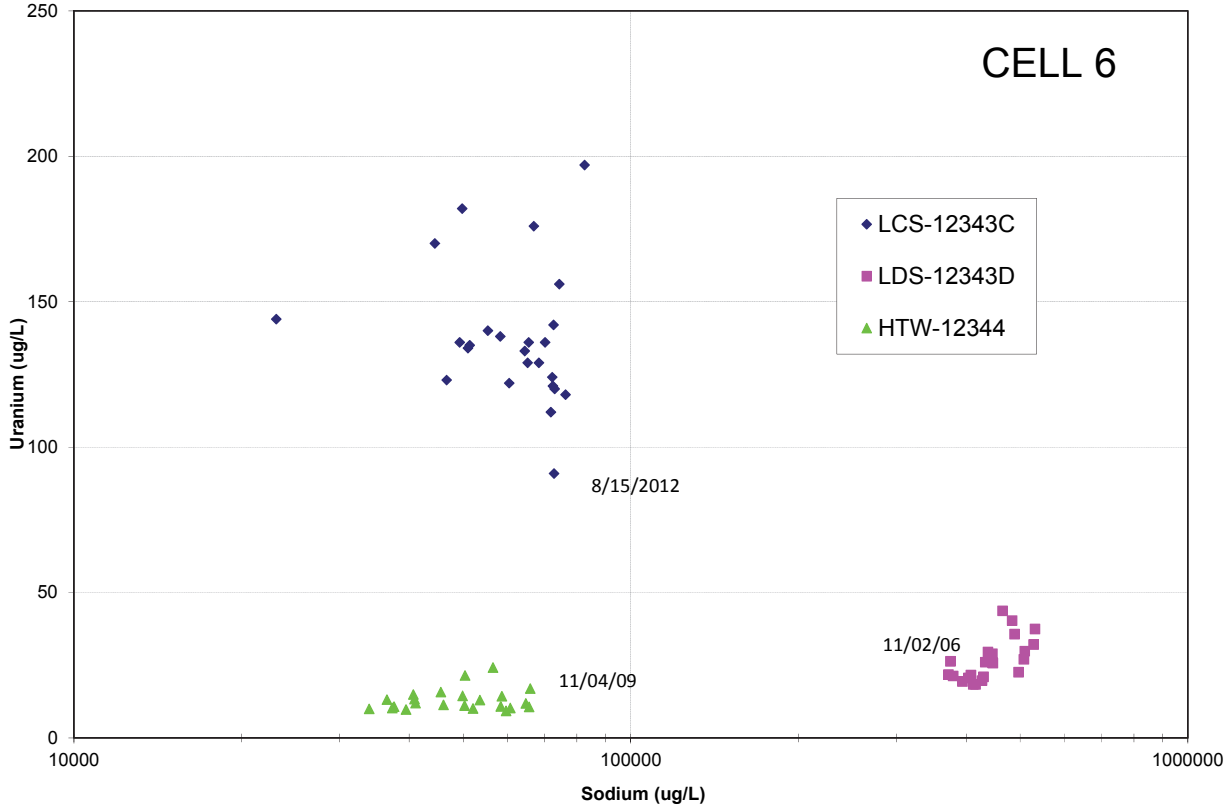


Figure A.5.6–29. Cell 6 Bivariate Plot for Uranium and Sodium

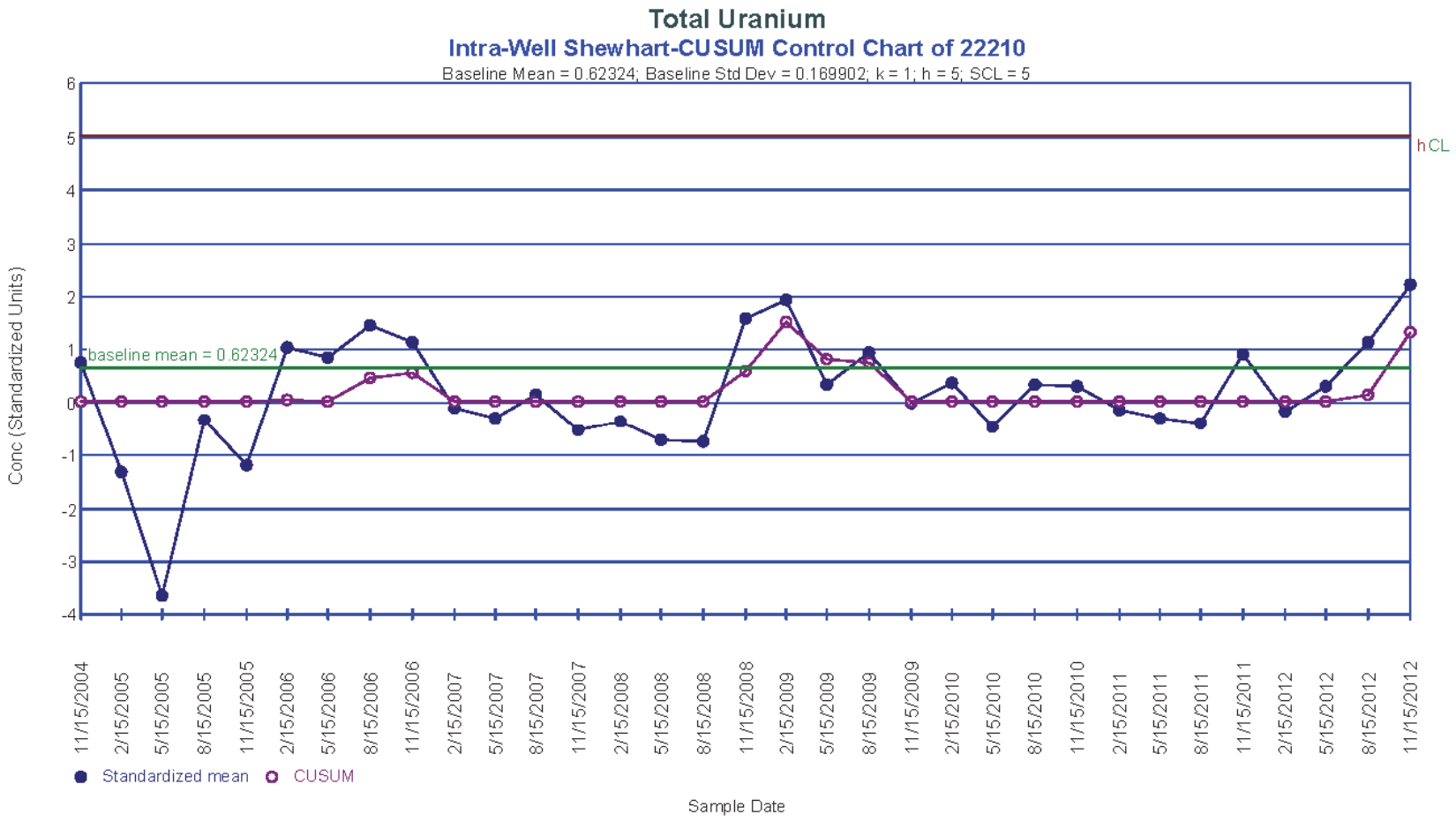


Figure A.5.6–30. Intra-Well Shewhart-CUSUM Control Chart (Total Uranium 22210)

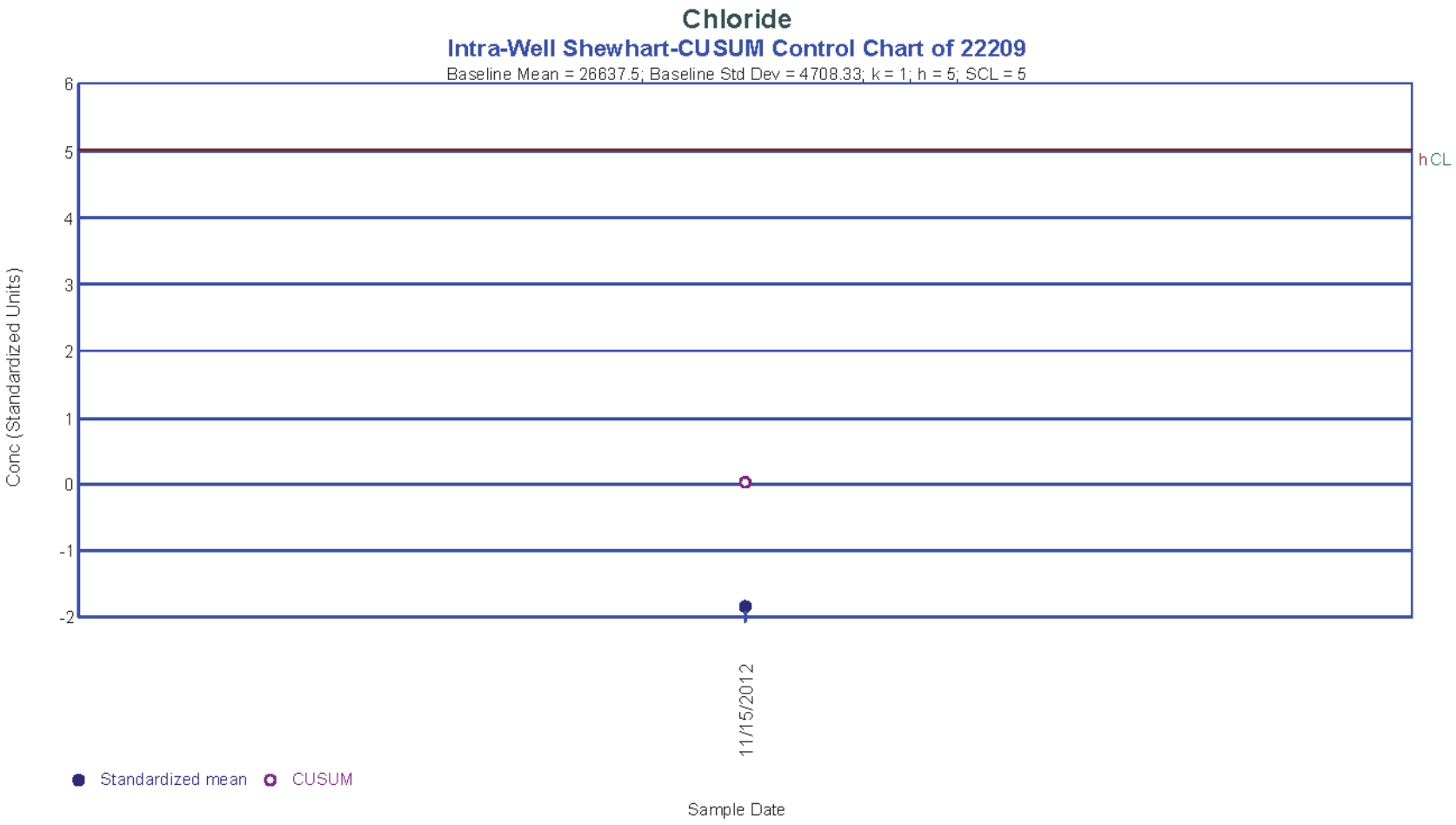


Figure A.5.6–31. Intra-Well Shewhart-CUSUM Control Chart (Chloride 22209)

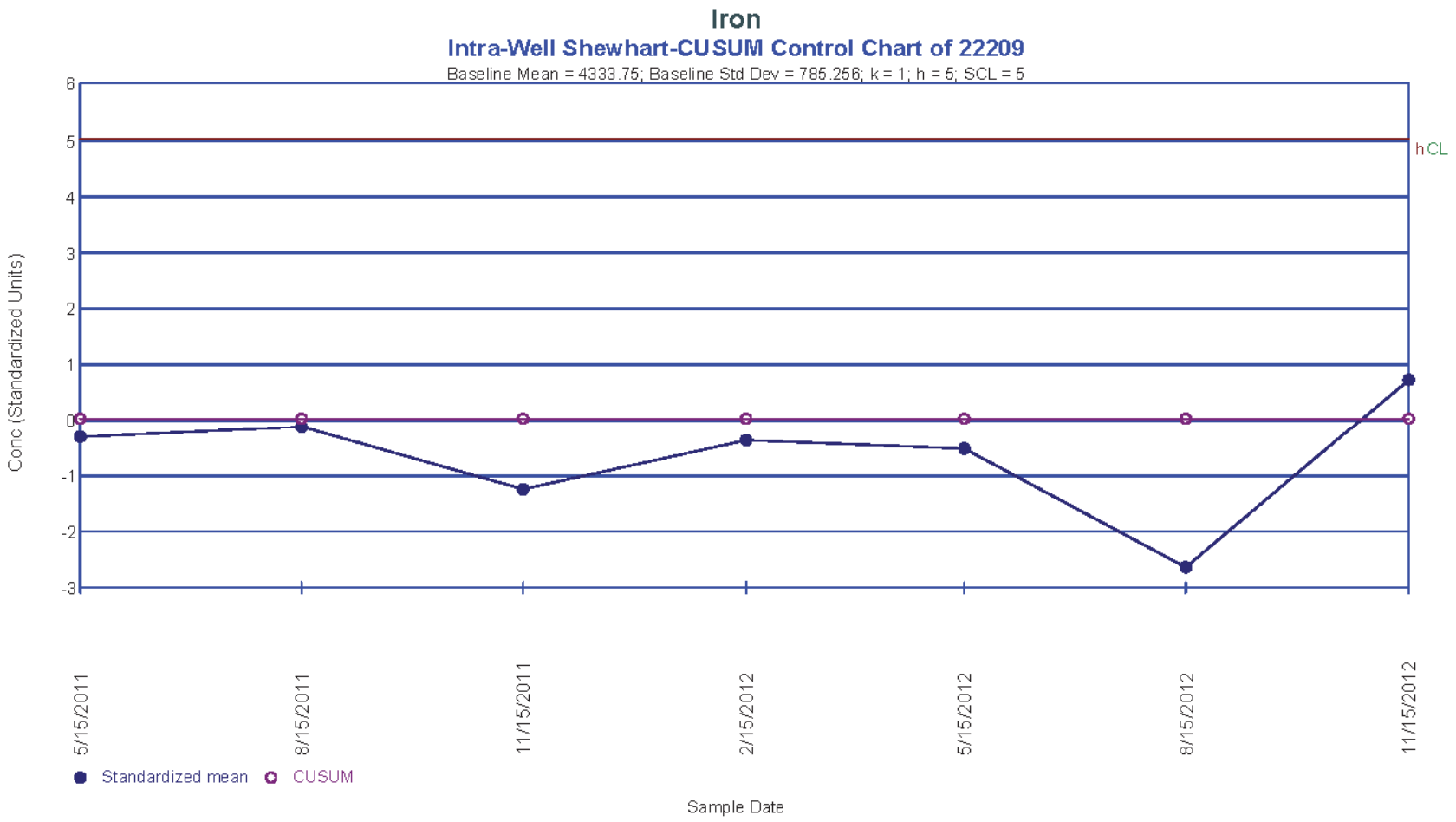


Figure A.5.6–32. Intra-Well Shewhart-CUSUM Control Chart (Iron 22209)

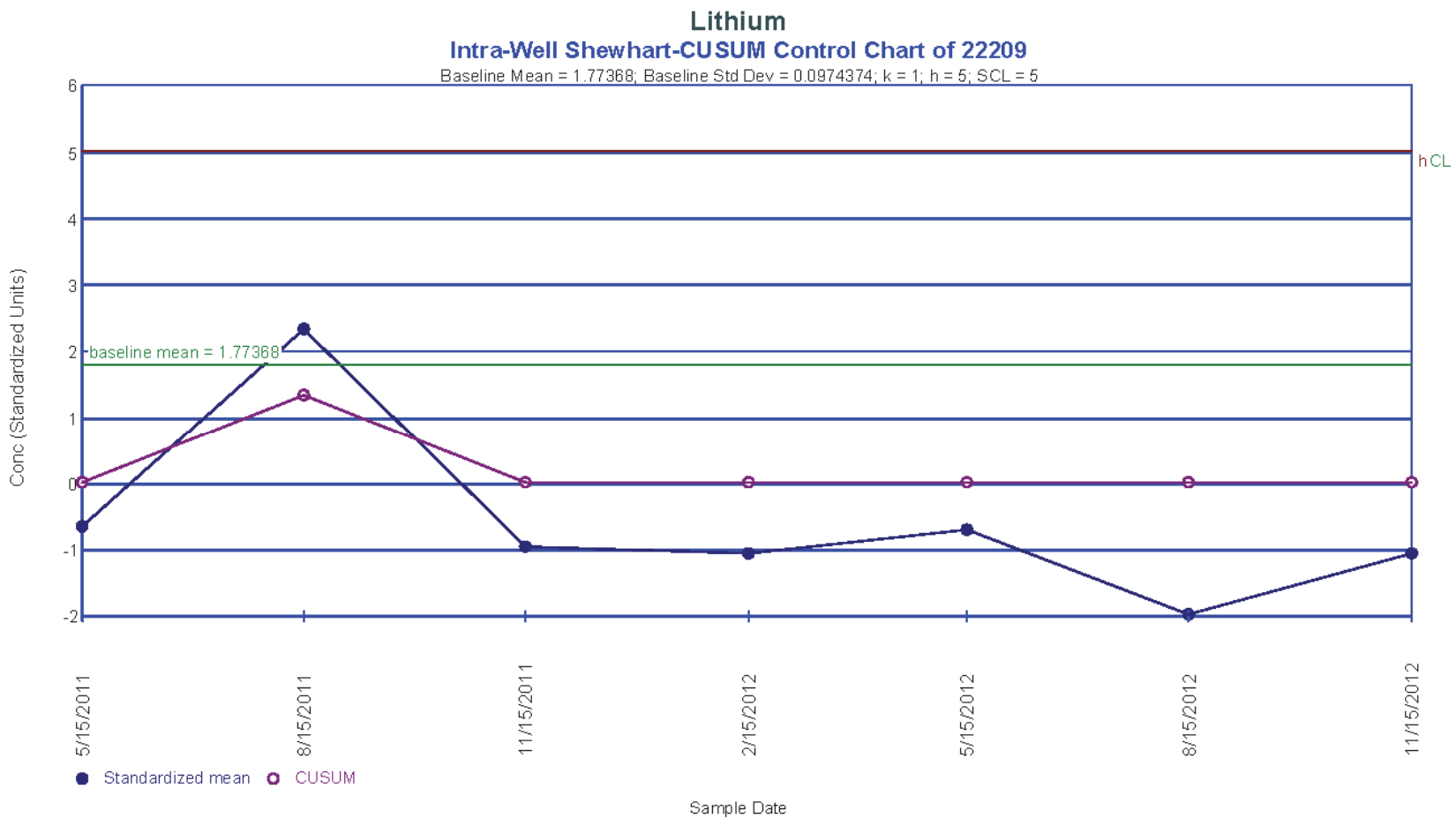


Figure A.5.6–33. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22209)

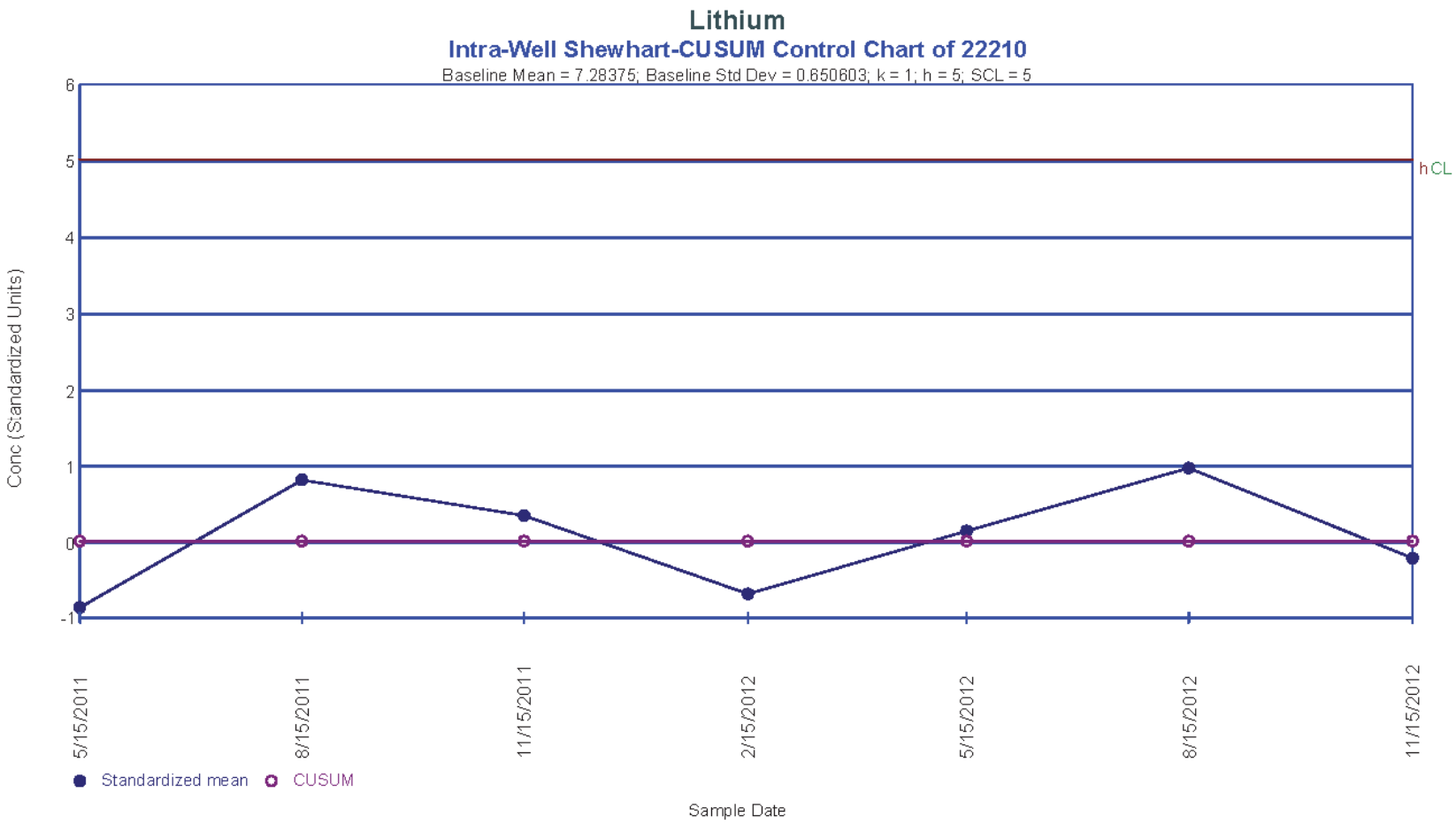


Figure A.5.6–34. Intra-Well Shewhart-CUSUM Control Chart (Lithium 22210)

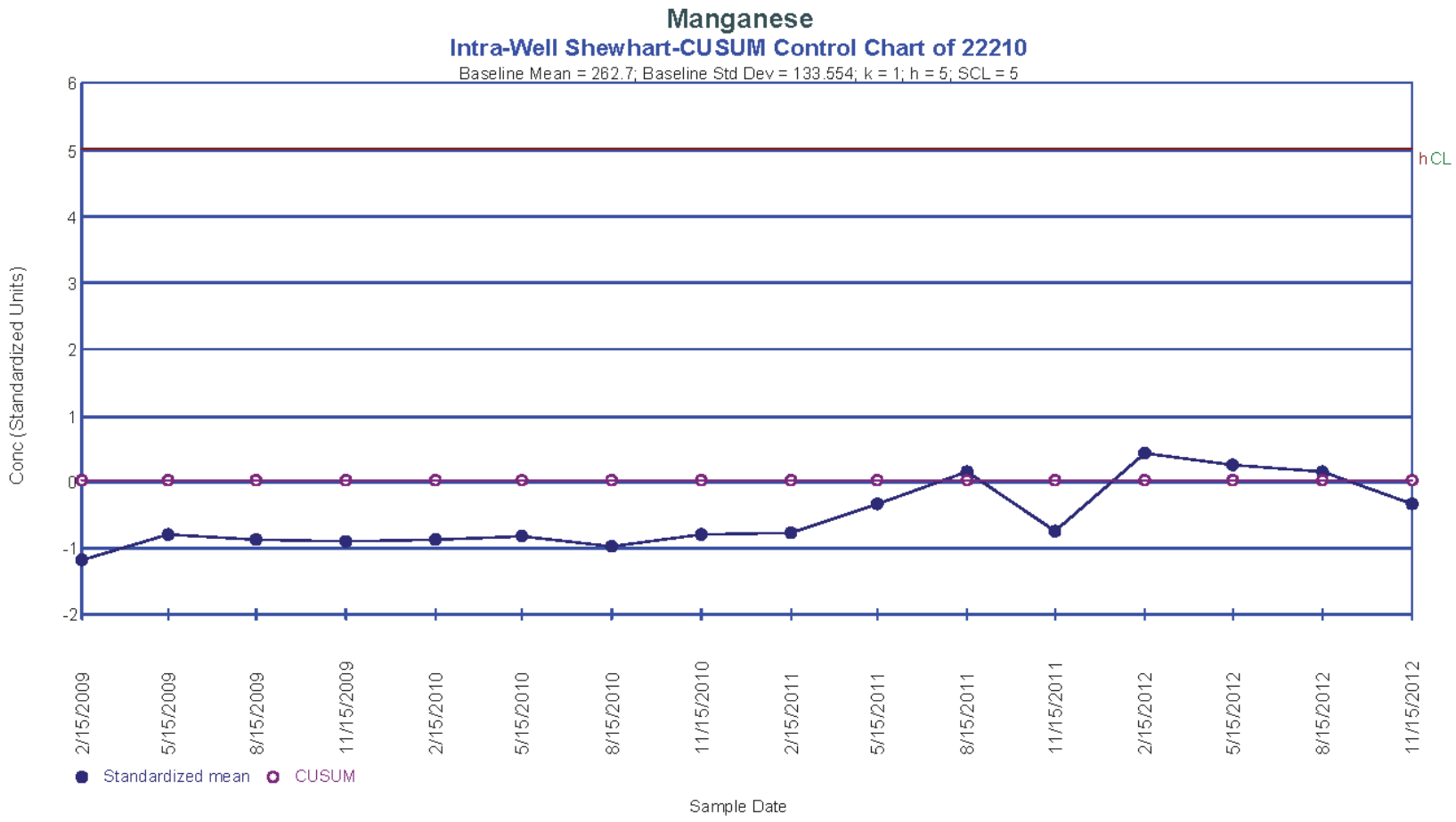


Figure A.5.6–35. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22210)

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Sub-attachment A.5.7

Cell 7

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The following information is provided in this sub-attachment:

- Quarterly monitoring summary statistics (refer to Table A.5.7–1)
- Annual LCS sample summary information for detected parameters (refer to Table A.5.7–2)
- LCS monthly accumulation volumes (refer to Figure A.5.7–1)
- LDS monthly accumulation volumes (refer to Figure A.5.7–2)
- OSDF horizontal till well 12344 water yield (refer to Figure A.5.7–3)
- GMA water levels and uranium concentration versus time (refer to Figures A.5.7–4 and A.5.7–5)
- Plots of concentration versus time (refer to Figures A.5.7–6A to A.5.7–28B)
- A bivariate plot for uranium-sodium (refer to Figure A.5.7–29)
- Control charts (refer to Figures A.5.7–30 to A.5.7–35)

A.5.7.1 Quarterly Monitoring Results

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within the cell is sampled in the LCS and LDS. Water quality beneath the cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present the results.

In 2012, 23 parameters were sampled in the LCS, LDS, and GMA wells of each cell. HTWs in all cells were sampled for arsenic, uranium, sodium, and sulfate. The Cell 7 HTW was dry during the fourth quarter of 2012, and the Cell 7 LDS was dry all year. Quarterly monitoring summary statistics are provided in Table A.5.7–1.

As shown in Table A.5.7–1, and summarized below, 7 of the 23 constituents sampled quarterly in the LCS, LDS, HTW, and GMA wells (uranium, sulfate, TOC, boron, manganese, selenium, and sodium) have upward concentration trends in the HTW and/or GMA wells based on the Mann-Kendall test for trend.

Parameters with upward concentration trends in the HTW and GMA Wells of Cell 7

Parameter	HTW[a] 12344	GMA-U[a] 22212	GMA-D[a] 22211
Uranium	Up		
Sulfate	Up	Up	Up
TOC		Up	Up
Boron		Up	Up
Manganese			Up
Selenium		Up	Up
Sodium	Up		

[a] HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer; TOC = total organic carbon. No entry indicates that the trend was not up.

The (uranium-sodium) bivariate plot for the Cell 7 LCS, LDS, and HTW is provided in Figure A.5.7–29. The plot shows that the chemical signature for uranium-sodium in the LCS, LDS, and HTW are separate and distinct; indicating that mixing between the horizons is not occurring. Therefore, the increasing concentrations measured beneath Cell 7 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell that are not related to cell performance.

A.5.7.2 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities –Unified Guidance* (EPA 2009) defines the process of creating a Shewart-CUSUM control chart. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected, the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared "out of control" if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit.

A minimum of eight samples are recommended for use in ChemStat software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat software plots both a CUSUM control limit (h) and a SCL on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL.

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat software though, by default, plots both the SCL and CUSUM control limit on the charts. As a "work-a-round", the SCL limit was defined as 5 to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

As shown in Table A.5.7–1 in gray shading, five constituents in the HTW and GMA wells of Cell 7 (TDS, TOX, lithium, sodium, and zinc) meet the criteria for control charts (i.e., more than eight samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in six control charts.

Constituent and Monitoring Point[a]	Assessment	Figure Number
TDS in the GMA-D	In Control	A.5.7-30
TOX in the GMA-U	In Control	A.5.7-31
Lithium in the GMA-D	In Control	A.5.7-32
Sodium in the GMA-D	In Control	A.5.7-33
Zinc in the GMA-U	In Control	A.5.7-34
Zinc in the GMA-D	In Control	A.5.7-35

[a] GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer; TDS = total dissolved solids; TOX = total organic halogens

The control charts are presented in Figures A.5.7–30 to A.5.7–35. All of the control charts exhibit "in control" conditions.

A.5.7.3 Annual LCS Sample Results

Annual LCS sampling results for Cell 7 are provided in Table A.5.7–2 for those parameters that have been detected at least once, and are not being sampled quarterly. No new Appendix I or PCB parameters were detected in the LCS of Cell 7 in 2012.

A.5.7.4 Cell 7 LDS Sampling

In addition to the 23 parameters being sampled for quarterly in the LCS, LDS, and GMA wells, the Cell 7 LDS is also being sampled for 1,1-dichloroethene.

The constituent 1,1-dichloroethene was detected for the first time in the LCS of Cell 7 in 2009. In 2010, 1,1-dichloroethene was detected again in the LCS of Cell 7, triggering sampling in the LDS beginning in 2011. Sampled for twice in the LDS of Cell 7 in 2011, 1,1-dichloroethene was not detected in the LDS of Cell 7. The LDS of Cell 7 was dry in 2012.

A.5.7.5 Summary and Conclusions

- The Cell 7 LDS was dry in 2012.
- The Cell 7 HTW was dry in the 4th quarter of 2012.
- Seven parameters monitored quarterly have an upward concentration trend in the HTW and/or GMA wells of Cell 7: uranium, sulfate, TOC, boron, manganese, selenium, and sodium.
- Separate and distinct chemical signatures for uranium and sodium in the LCS, LDS, and HTW of Cell 7 indicate that water is not mixing between the horizons. Therefore, upward concentration trends beneath Cell 7 (i.e., HTW and/or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell, and not to cell performance.
- Six control charts were constructed for Cell 7 parameters. All of the control charts exhibit "in control" conditions.
- No new Appendix I or PCB parameters were detected in the LCS of Cell 7 in 2012.

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Table.5.7–1. Summary Statistics for Cell 7

Parameter	Horizon[a]	Location	Number of Detects	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Total Uranium (µg/L)	LCS	12344C	33	33	100	4.72	355	173	58	Undefined	None	Not Detected	
	LDS	12344D	27	27	100	12.2	33.7	24.5	5.4	Normal	None	Not Detected	
	HTW	12344	33	33	100	2.00	8.61	3.73	1.69	LogNormal	Up	Detected	
	GMA-U	22212	33	35	94.3	ND	5.53	0.47	1.11	Undefined	None	Not Detected	
	GMA-D	22211	35	36	97.2	ND	2.62	0.328	0.613	Undefined	None	Not Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12344C	21	21	100	86	822	430	168	Normal	Up	Detected	
	LDS	12344D	13	13	100	155	586	383	122	Normal	None	Not Detected	
	GMA-U	22212	8	8	100	316	345	334	10	Normal	None	Not Detected	
	GMA-D	22211	8	8	100	284	423	371	44	Normal	None	Not Detected	
Chloride (mg/L)	LCS	12344C	21	21	100	26.7	175	131	49	Undefined	Up	Detected	
	LDS	12344D	13	13	100	43.0	197	46.4	47.2	Undefined	None	Detected	
	GMA-U	22212	8	8	100	18.3	34.9	27.0	5.0	Normal	None	Not Detected	
	GMA-D	22211	8	8	100	19.7	31.7	25.3	3.9	Normal	None	Not Detected	
Nitrate, Nitrite (mg/L)	LCS	12344C	17	22	77.3	ND	10.7	3.16	2.84	Undefined	Up	Detected	
	LDS	12344D	10	13	76.9	ND	9.03	3.34	2.62	LogNormal	None	Not Detected	
	GMA-U	22212	1	8	12.5	ND	0.0250	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-D	22211	1	8	12.5	ND	0.0325	Insufficient	Insufficient	LogNormal	None	Not Detected	
Sulfate (mg/L)	LCS	12344C	33	33	100	122	4440	3010	1160	Undefined	Up	Detected	
	LDS	12344D	27	27	100	1280	4030	1740	780	Undefined	Up	Detected	
	HTW	12344	28	28	100	80.4	657	136	157	Undefined	Up	Detected	
	GMA-U	22212	35	35	100	96.6	731	231	131	LogNormal	Up	Detected	
	GMA-D	22211	35	35	100	152	3640	316	572	Undefined	Up	Detected	
Total Dissolved Solids (mg/L)	LCS	12344C	21	21	100	960	6870	5950	1760	Undefined	Up	Detected	
	LDS	12344D	11	11	100	2590	6870	4440	1450	Normal	Up	Not Detected	
	GMA-U	22212	15	15	100	604	1510	698	275	Undefined	Down	Not Detected	
	GMA-D	22211	15	15	100	602	1350	1030	220	Normal	None	Not Detected	
Total Organic Carbon (mg/L)	LCS	12344C	29	33	87.9	ND	5.55	2.31	0.84	LogNormal	None	Not Detected	
	LDS	12344D	27	27	100	2.99	8.80	5.60	1.36	Normal	None	Not Detected	
	GMA-U	22212	30	35	85.7	ND	2.24	1.30	0.50	Normal	Up	Detected	
	GMA-D	22211	29	35	82.9	ND	2.15	1.44	0.50	Undefined	Up	Detected	
Total Organic Halogens (mg/L)	LCS	12344C	23	33	69.7	ND	0.039	0.0158	0.0112	LogNormal	None	Detected	
	LDS	12344D	20	27	74.1	ND	0.064	0.0291	0.0140	Normal	Up	Not Detected	
	GMA-U	22212	12	35	34.3	ND	0.050	0.0052	0.0083	LogNormal	None	Not Detected	
	GMA-D	22211	9	35	25.7	ND	0.054	0.0017	0.0092	Undefined	None	Not Detected	
Arsenic (mg/L)	LCS	12344C	8	26	30.8	ND	0.179	0.00375	0.0435	Undefined	None	Not Detected	
	LDS	12344D	4	20	20.0	ND	0.0480	0.0025	0.0108	Undefined	None	Not Detected	
	HTW	12344	1	21	4.8	ND	0.0298	Insufficient	Insufficient	Undefined	None	Not Detected	
	GMA-U	22212	4	15	26.7	ND	0.0394	0.0025	0.0112	Undefined	None	Not Detected	
	GMA-D	22211	5	24	20.8	ND	0.0323	0.0025	0.0088	Undefined	None	Detected	
Barium (mg/L)	LCS	12344C	21	21	100	0.0221	0.112	0.0337	0.0271	Undefined	Down	Detected	
	LDS	12344D	13	13	100	0.0197	0.0891	0.0362	0.0193	LogNormal	Down	Not Detected	
	GMA-U	22212	8	8	100	0.0508	0.0971	0.0747	0.0163	Normal	None	Not Detected	
	GMA-D	22211	8	8	100	0.0429	0.0693	0.0535	0.0092	Normal	None	Not Detected	
Boron (mg/L)	LCS	12344C	33	33	100	0.926	1.35	1.17	0.10	Normal	None	Not Detected	0.299(Q4-04)0.0625(Q1-05)0.288(Q2-05) 0.249(Q3-05)0.249(Q4-05)
	LDS	12344D	27	27	100	0.168	2.10	0.309	0.382	Undefined	Up	Detected	
	GMA-U	22212	33	35	94.3	ND	0.0458	0.0352	0.0063	Normal	Up	Detected	
	GMA-D	22211	32	35	91.4	ND	0.0433	0.0298	0.0068	Undefined	Up	Detected	

Table A.5.7−1 (continued). Summary Statistics for Cell 7

Parameter	Horizon[a]	Location	Number of Detects	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Calcium (mg/L)	LCS	12344C	21	21	100	153	759	565	160	Undefined	None	Not Detected	
	LDS	12344D	13	13	100	155	474	312	121	LogNormal	None	Detected	
	GMA-U	22212	8	8	100	141	377	153	80	Undefined	None	Not Detected	
	GMA-D	22211	8	8	100	153	263	211	41	Normal	None	Not Detected	
Cobalt (mg/L)	LCS	12344C	13	26	50.0	ND	0.0080	0.00103	0.00206	Undefined	Down	Detected	
	LDS	12344D	10	20	50.0	ND	0.0025	0.0008	0.0005	LogNormal	None	Not Detected	
	GMA-U	22212	1	15	6.7	ND	0.00138	Insufficient	Insufficient	Undefined	None	Detected	
	GMA-D	22211	0	15	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
Copper (mg/L)	LCS	12344C	17	26	65.4	ND	0.0266	0.0108	0.0086	Undefined	None	Not Detected	
	LDS	12344D	13	20	65.0	ND	0.0239	0.00833	0.00658	LogNormal	Down	Detected	
	GMA-U	22212	6	8	75.0	ND	0.00993	0.00571	0.00422	LogNormal	None	Not Detected	
	GMA-D	22211	5	8	62.5	ND	0.00956	0.00440	0.00392	Normal	None	Not Detected	
Iron (mg/L)	LCS	12344C	25	26	96.2	ND	18.7	4.30	4.68	LogNormal	Down	Not Detected	
	LDS	12344D	18	20	90.0	ND	2.74	0.986	0.820	Undefined	Down	Detected	
	GMA-U	22212	15	15	100	3.76	20.5	7.87	4.53	LogNormal	Down	Detected	
	GMA-D	22211	15	15	100	4.88	11.2	7.79	1.99	Normal	Down	Not Detected	
Lithium (mg/L)	LCS	12344C	24	24	100	0.0188	0.695	0.192	0.144	Undefined	Up	Detected	
	LDS	12344D	19	19	100	0.0529	0.226	0.119	0.053	LogNormal	Up	Detected	
	GMA-U	22212	15	15	100	0.00477	0.00892	0.00548	0.00118	Undefined	Down	Not Detected	
	GMA-D	22211	15	15	100	0.00555	0.00930	0.00700	0.00103	Normal	None	Not Detected	
Magnesium (mg/L)	LCS	12344C	21	21	100	60.5	903	510	302	Undefined	Up	Detected	
	LDS	12344D	13	13	100	61.1	369	88.8	117	Undefined	None	Detected	
	GMA-U	22212	8	8	100	28.6	54.6	34.2	7.7	Undefined	None	Not Detected	
	GMA-D	22211	8	8	100	34.6	64.7	50.6	11.3	Normal	None	Not Detected	
Manganese (mg/L)	LCS	12344C	14	26	53.8	ND	0.991	0.013	0.258	Undefined	Down	Detected	
	LDS	12344D	13	20	65.0	ND	1.20	0.057	0.266	LogNormal	None	Not Detected	
	GMA-U	22212	15	15	100	0.219	1.23	0.286	0.269	Undefined	None	Not Detected	
	GMA-D	22211	24	24	100	0.256	0.68	0.460	0.126	Normal	Up	Detected	
Nickel (mg/L)	LCS	12344C	22	26	84.6	ND	0.0265	0.00858	0.00775	LogNormal	Down	Detected	
	LDS	12344D	16	20	80.0	ND	0.0138	0.00680	0.00384	Normal	Down	Not Detected	
	GMA-U	22212	4	15	26.7	ND	0.00493	0.00075	0.00131	Undefined	None	Not Detected	
	GMA-D	22211	4	24	16.7	ND	0.00520	0.00075	0.00106	Undefined	None	Detected	
Potassium (mg/L)	LCS	12344C	21	21	100	8.12	61.4	47.1	14.4	Undefined	Up	Detected	
	LDS	12344D	13	13	100	13.2	97.9	32.6	24.3	LogNormal	None	Not Detected	
	GMA-U	22212	8	8	100	3.47	4.81	3.60	0.44	Undefined	None	Not Detected	
	GMA-D	22211	8	8	100	2.62	3.45	3.04	0.34	Normal	None	Not Detected	

Table A.5.7−1 (continued). Summary Statistics for Cell 7

Parameter	Horizon[a]	Location	Number of Detects	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Selenium (mg/L)	LCS	12344C	6	26	23.1	ND	0.0147	0.00583	0.00413	LogNormal	Up	Not Detected	0.171(Q4-09) 0.0605(Q1-10)
	LDS	12344D	3	20	15.0	ND	0.0477	0.00712	Insufficient	LogNormal	None	Not Detected	
	GMA-U	22212	2	15	13.3	ND	0.00868	Insufficient	Insufficient	Undefined	Up	Detected	
	GMA-D	22211	1	15	6.7	ND	0.00786	Insufficient	Insufficient	Undefined	Up	Detected	
Sodium (mg/L)	LCS	12344C	26	26	100	18.1	103	87.8	24.9	Undefined	Up	Detected	
	LDS	12344D	20	20	100	186	913	584	166	Normal	None	Not Detected	
	HTW	12344	21	21	100	19.8	37.4	30.3	6.8	Undefined	Up	Detected	
	GMA-U	22212	15	15	100	19.2	27.0	22.2	2.6	Normal	Down	Detected	
	GMA-D	22211	15	15	100	11.1	19.2	15.0	2.5	Normal	None	Not Detected	
Zinc (mg/L)	LCS	12344C	15	26	57.7	ND	0.154	0.0176	0.0378	Undefined	Down	Not Detected	
	LDS	12344D	17	20	85.0	ND	5.16	0.0255	1.43	Undefined	Up	Detected	
	GMA-U	22212	10	15	66.7	ND	0.0468	0.00848	0.0112	LogNormal	None	Not Detected	
	GMA-D	22211	14	24	58.3	ND	0.0205	0.00467	0.00407	LogNormal	None	Not Detected	

Note 1: Shading identifies a horizontal till well or Great Miami Aquifer well, with more than 8 samples, normal or lognormal distribution, no trend, and no serial correlation. These wells meet control chart criteria.

Note 2: Data used in this table has been standardized to quarterly.

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]ND = not detected; NA = not applicable

[c]Averages were determined based on the distribution assumption.

[d]Insufficient is used for Distribution Type, Trend, or Serial Correlation whenever there is not enough data to run the test, for average whenever there is less than 4 detetions, and for standard deviation whenever there are less than 5 detections.

[e]Data distribution based on the Shapiro-Wilk statistic.

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[f]Trend based on nonparametric Mann-Kendall procedure.

[g]Serial correlation based on Rank Von Neumann test.

[h]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 25).

[i]Q = quarterly

Table A.5.7–2. Cell 7 Annual LCS Sample Summary Information for Detected Parameters

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	DETECTED IN 2012	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)
General Chemistry											
Ammonia (mg/L)	9	4	44.4	Yes	0.026	0.254	0.129	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganics											
Beryllium (mg/L)	9	2	22.2	No	0.00017	0.00025	0.0002	0.004 mg/L(0)	-	-	0.0343 mg/L(0)
Cadmium (mg/L)	9	1	11.1	No	0.0002	-	-	0.014 mg/L(0)	0.014 mg/L(0)	-	0.05 mg/L(0)
Chromium (mg/L)	9	2	22.2	No	0.0055	0.0292	0.0174	0.022 mg/L[g](1)	0.021 mg/L(1)	0.0046 mg/L(2)	0.818 mg/L(0)
Lead (mg/L)	9	1	11.1	No	0.0061	-	-	0.015 mg/L(0)	0.022 mg/L(0)	0.0016 mg/L(1)	0.0114 mg/L(0)
Thallium (mg/L)	9	1	11.1	No	0.00046	-	-	-	-	-	0.0028 mg/L(0)
Vanadium (mg/L)	9	1	11.1	No	0.0051	-	-	0.038 mg/L(0)	0.012 mg/L(0)	0.005 mg/L(1)	0.299 mg/L(0)
Radionuclides											
Technetium-99 (pCi/L)	17	6	35.3	No	0.86	16.2	9.05	94 pCi/L(0)	22 pCi/L(0)	30 pCi/L(0)	6130 pCi/L(0)
Organics											
1,1-Dichloroethene (ug/L)	15	3	20.0	No	0.455	0.72	0.558	7 ug/L(0)	-	-	-
Acetone (ug/L)	8	1	12.5	No	3.5	-	-	-	-	-	-
Total Xylenes (ug/L)	8	1	12.5	No	1.01	-	-	-	-	-	-

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on hexavalent chromium from Operable Unit 5 Record of Decision, Table 9-4.

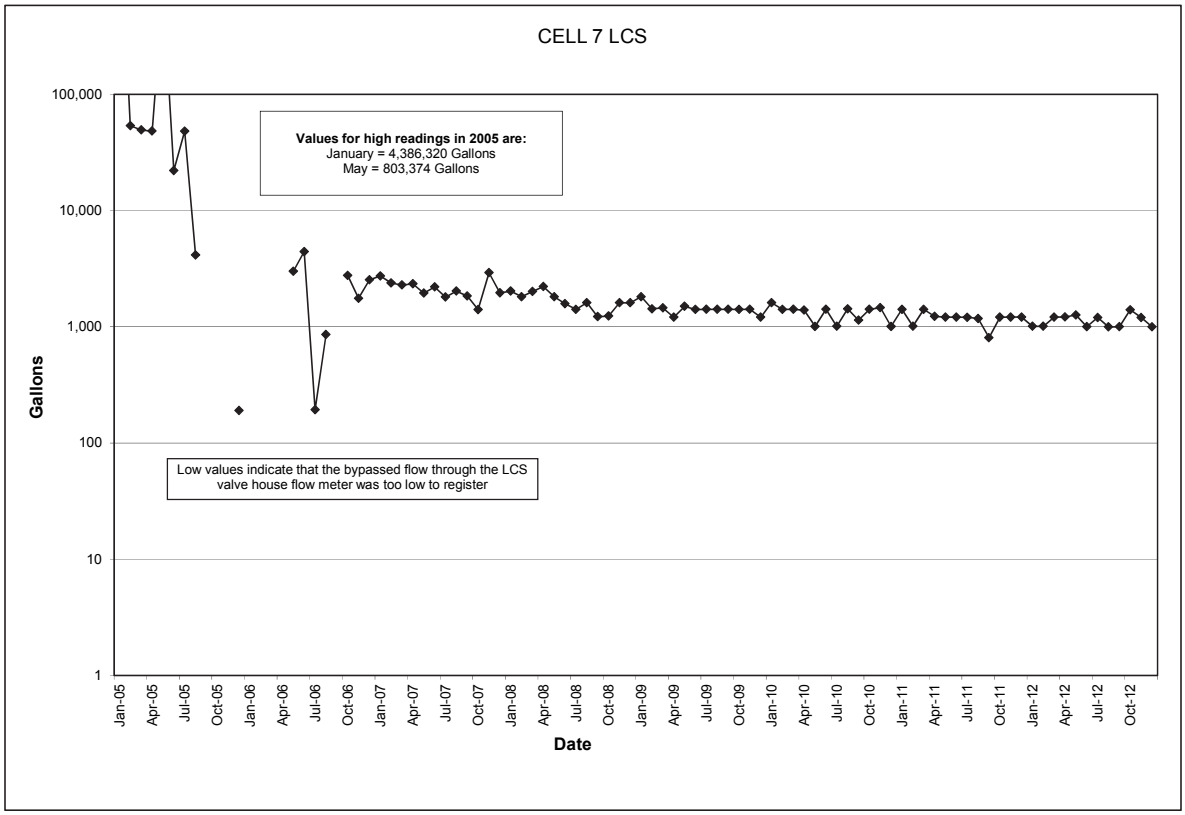


Figure A.5.7–1. Monthly Accumulation Volumes for Cell 7 LCS

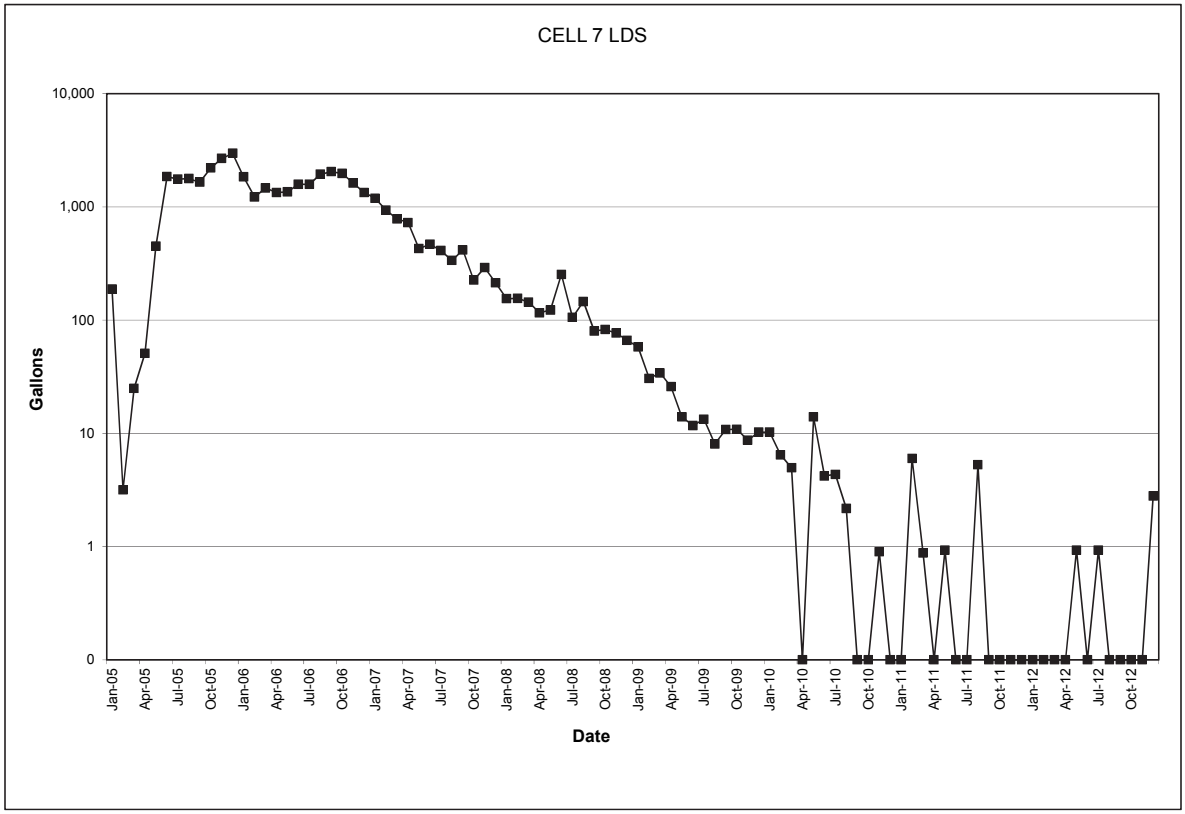
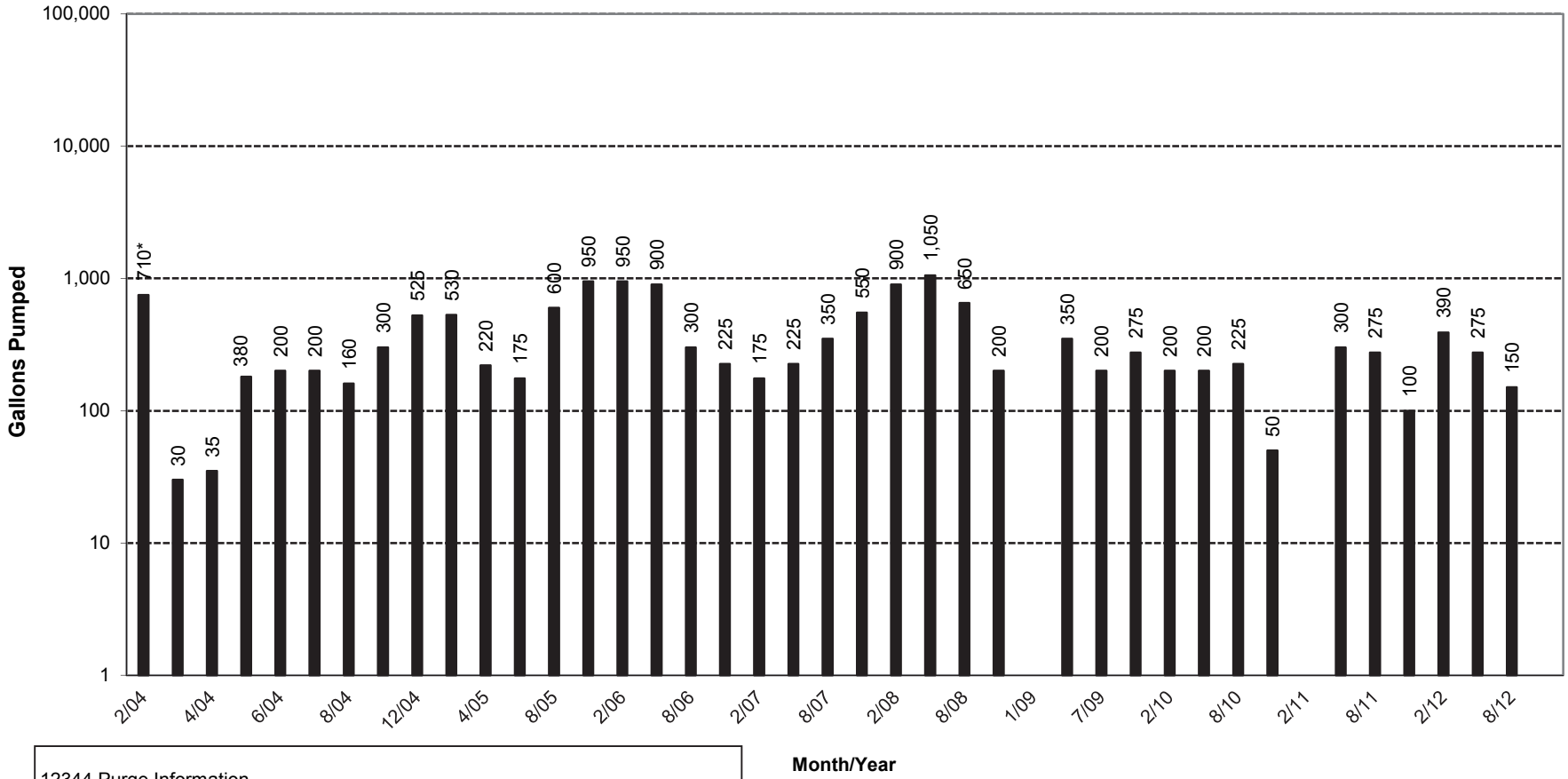


Figure A.5.7–2. Monthly Accumulation Volumes for Cell 7 LDS



12344 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
2004:	2380	n=9	264
2005:	2475	n=5	495
2006:	2375	n=4	594
2007:	1300	n=4	325
2008:	2800	n=4	700
2009:	825	n=3	275
2010:	675	n=4	169
2011:	675	n=4	169
2012:	815	n=4	204
Overall:			349

*More than one purge of the well was completed during this month to drain perched water and infiltrating surface water so the compacted clay liner could be constructed.

Figure A.5.7–3. OSDF Horizontal Till Well 12343 (Cell 7) Water Yield

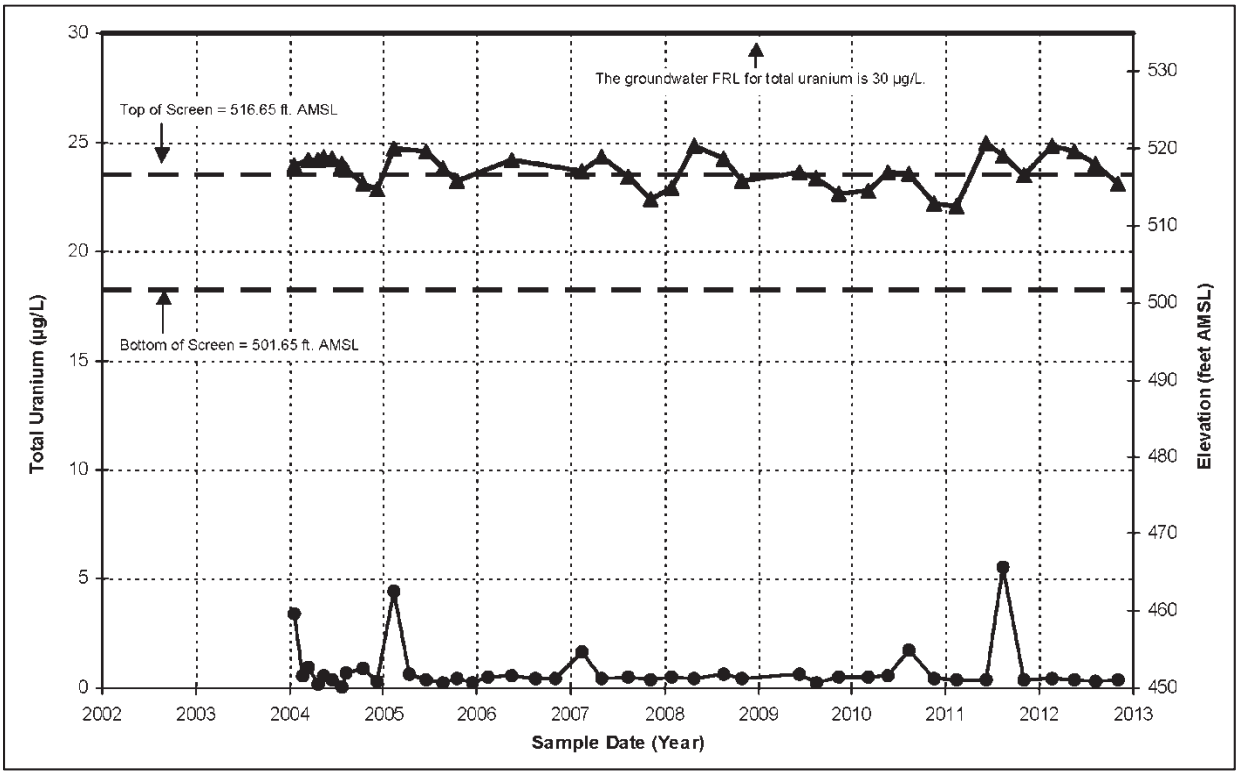


Figure A.5.7–4. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 7 Upgradient Monitoring Well 22212

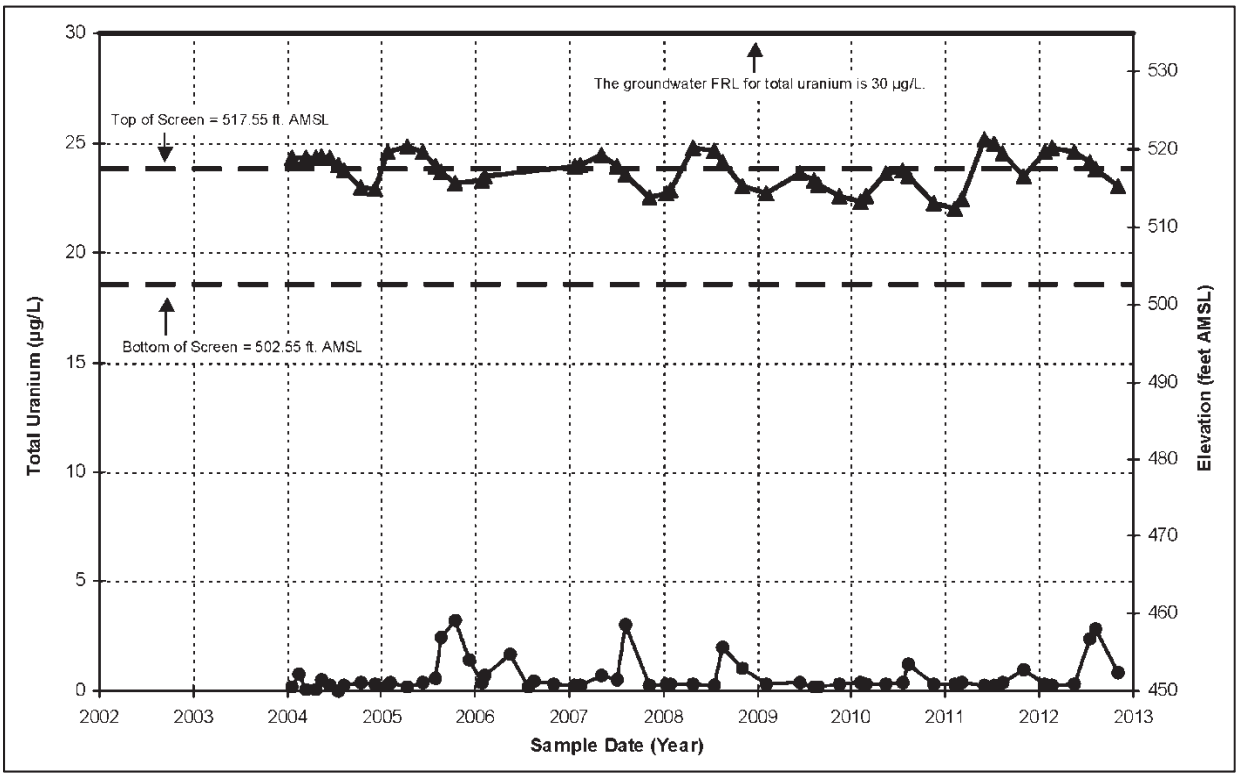


Figure A.5.7–5. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 7 Downgradient Monitoring Well 22211

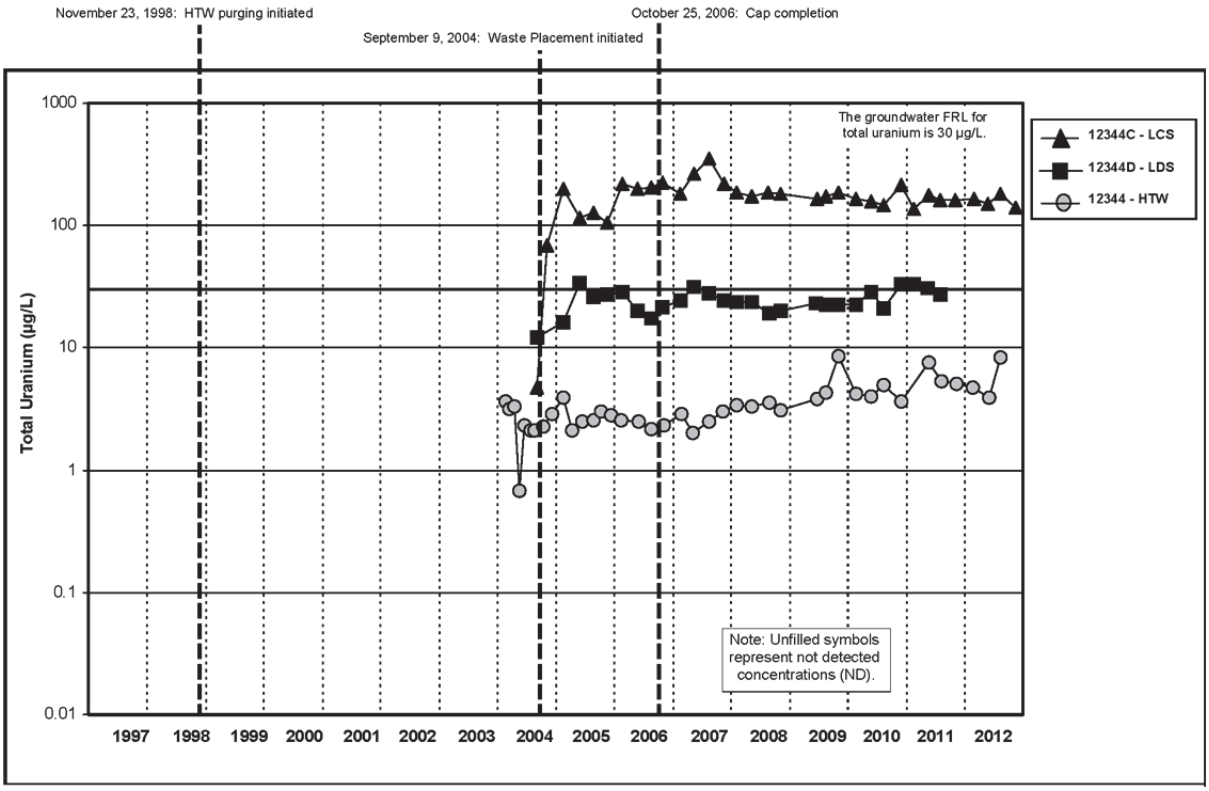


Figure A.5.7–6A. Cell 7 Uranium, Total Concentration vs. Time Plot for LCS, LDS, and HTW

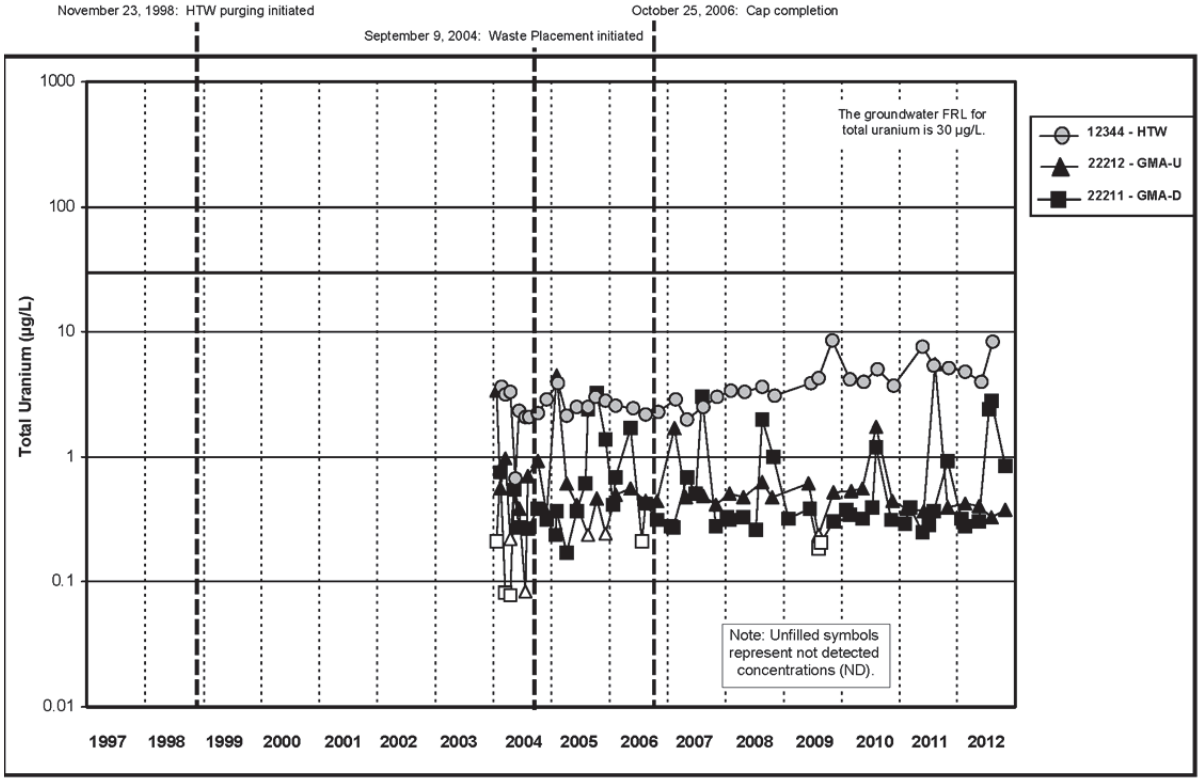


Figure A.5.7–6B. Cell 7 Uranium, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

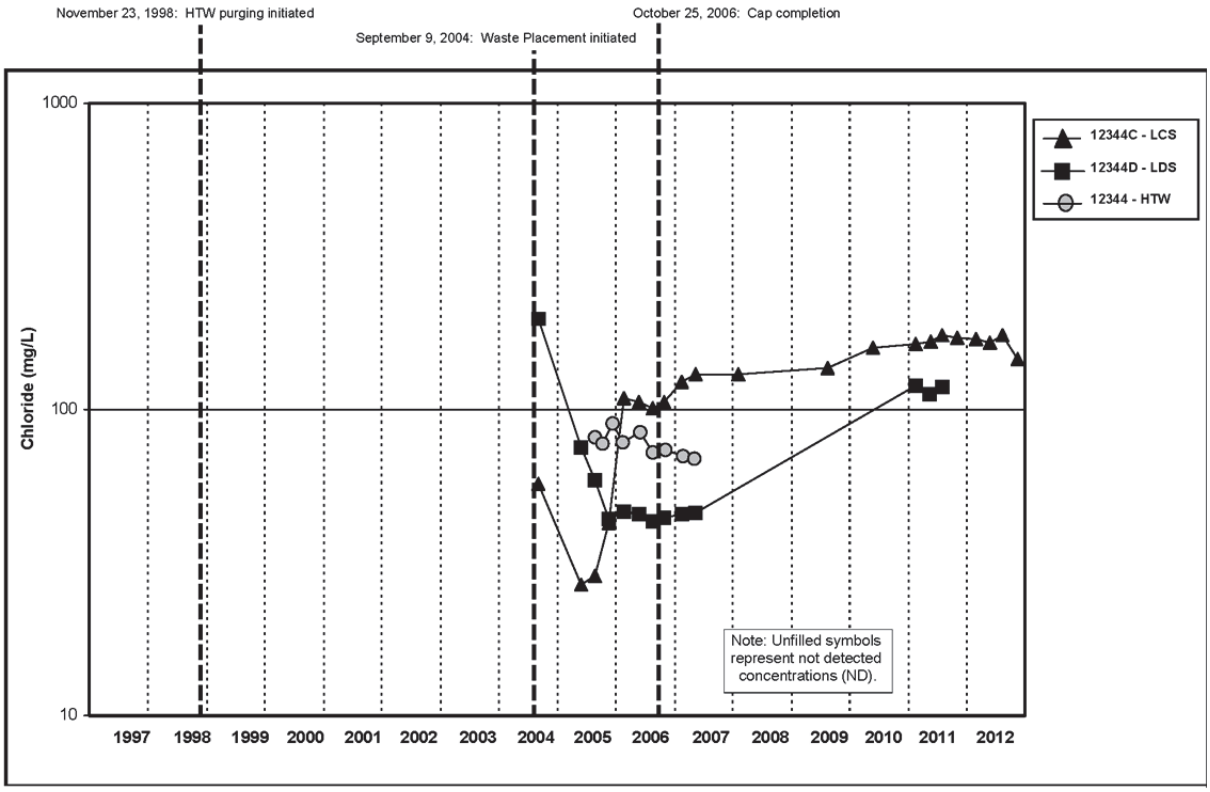


Figure A.5.7–7A. Cell 7 Chloride Concentration vs. Time Plot for LCS, LDS, and HTW

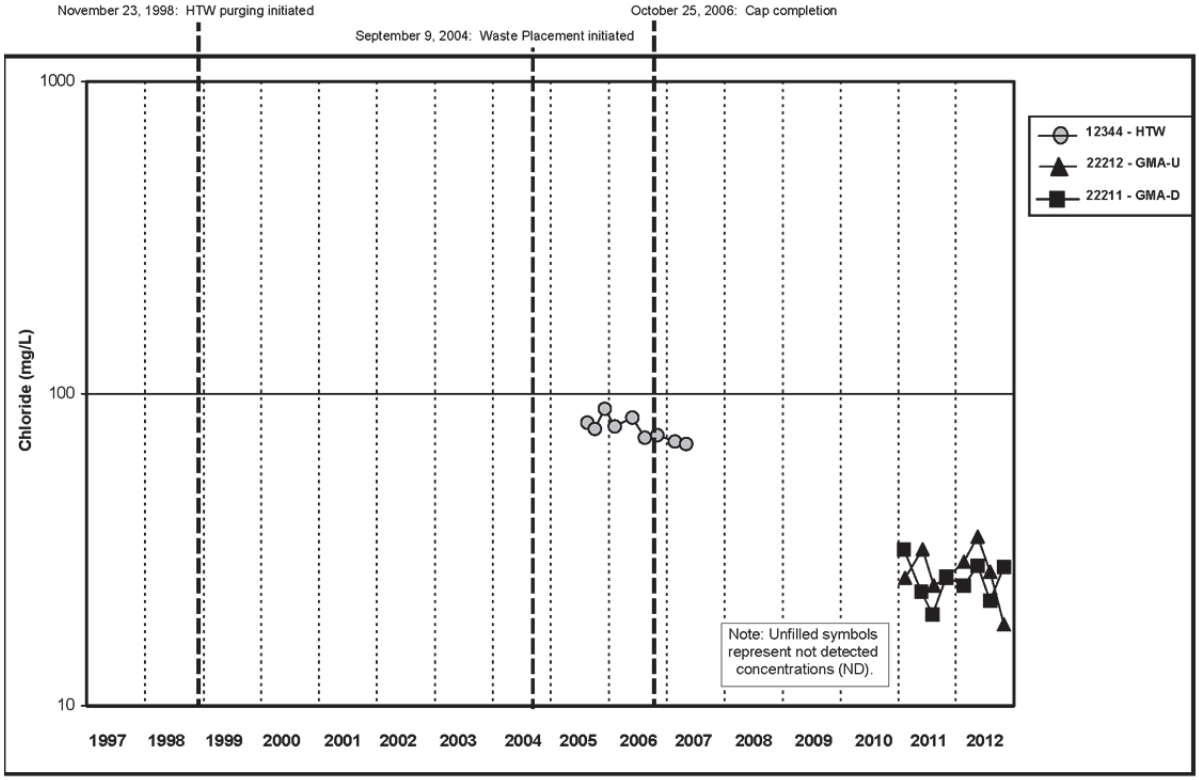


Figure A.5.7–7B. Cell 7 Chloride Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

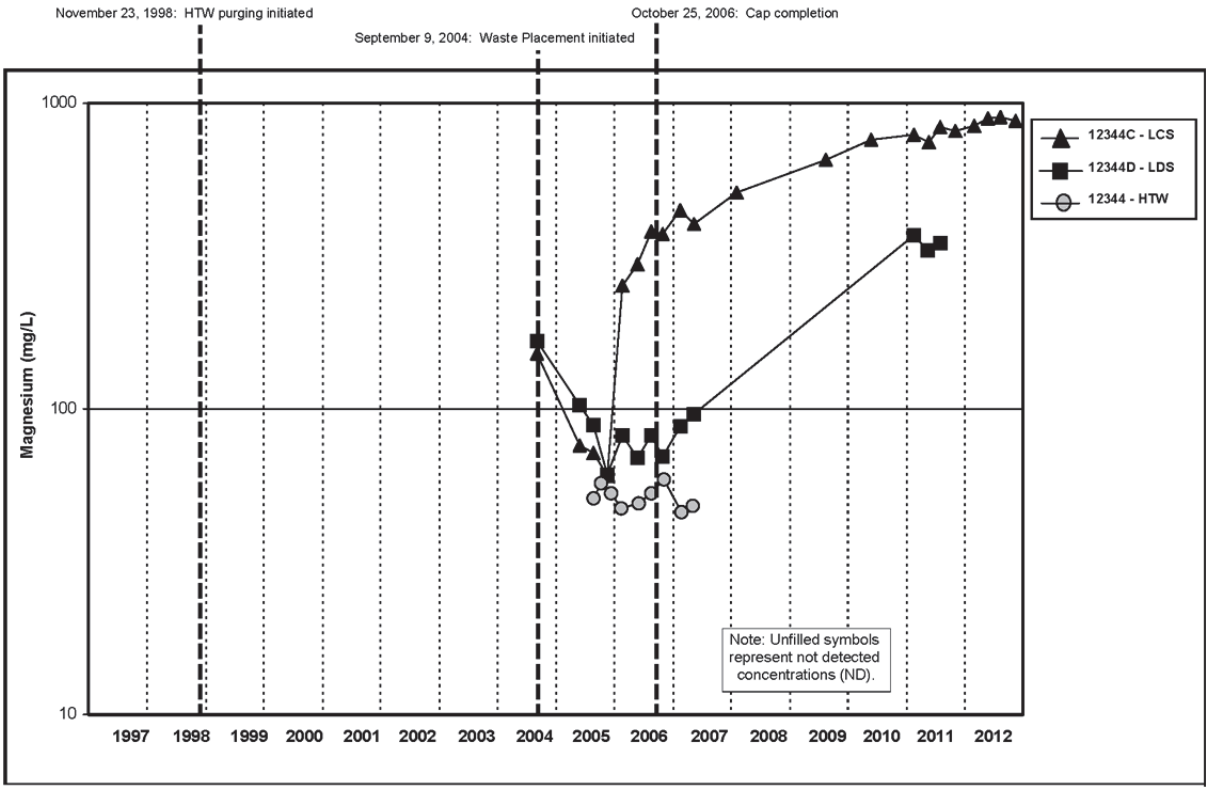


Figure A.5.7–8A. Cell 7 Magnesium Concentration vs. Time Plot for LCS, LDS, and HTW

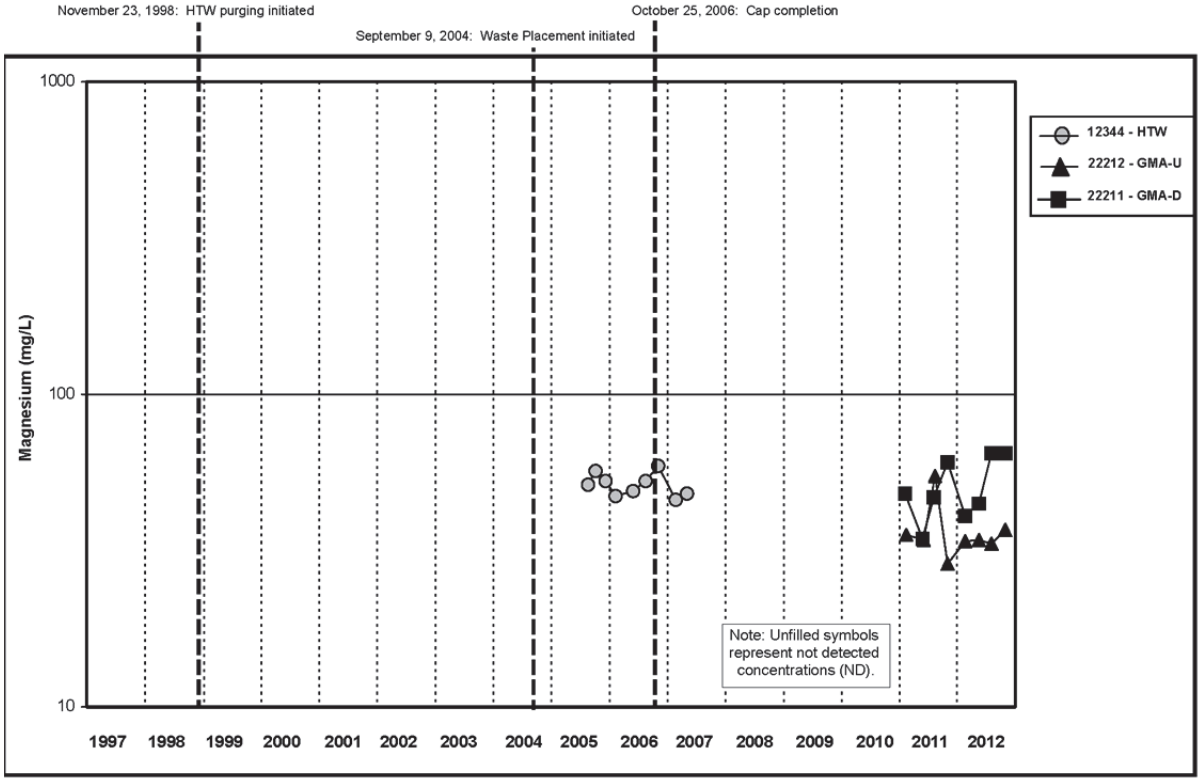


Figure A.5.7–8B. Cell 7 Magnesium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

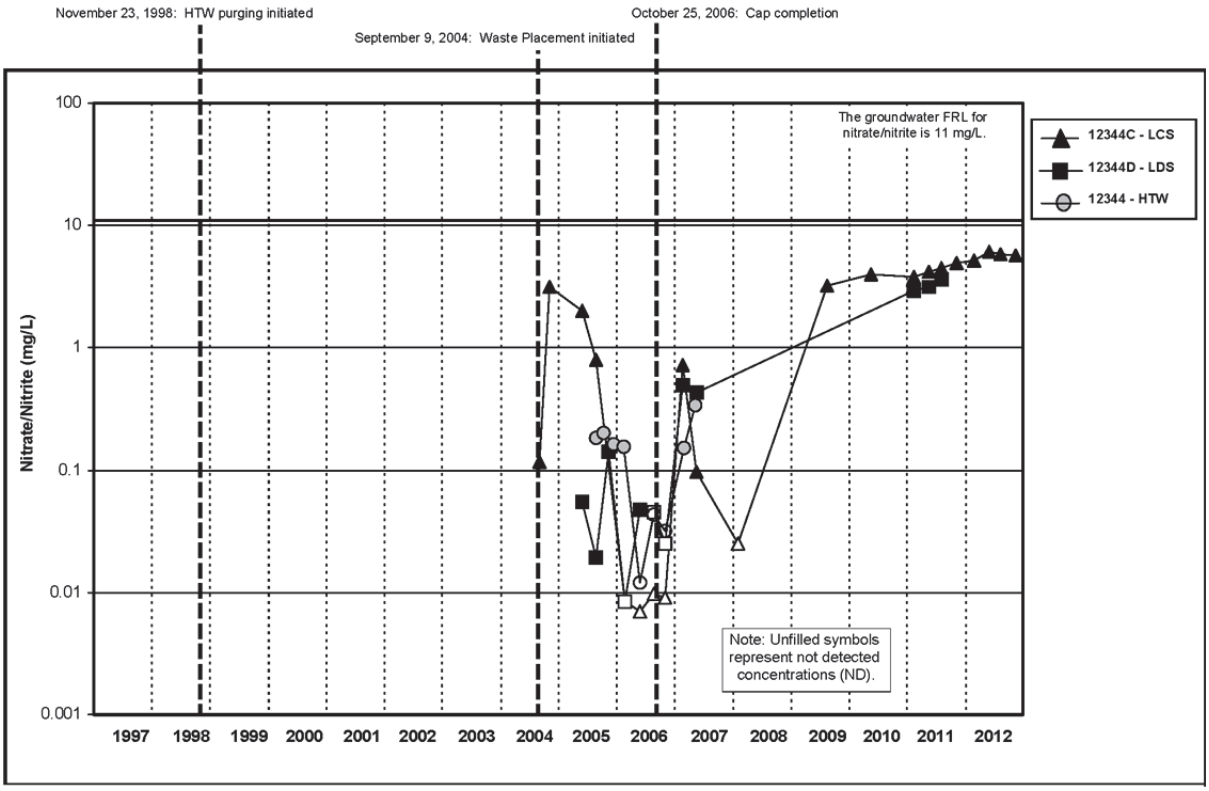


Figure A.5.7–9A. Cell 7 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for LCS, LDS, and HTW

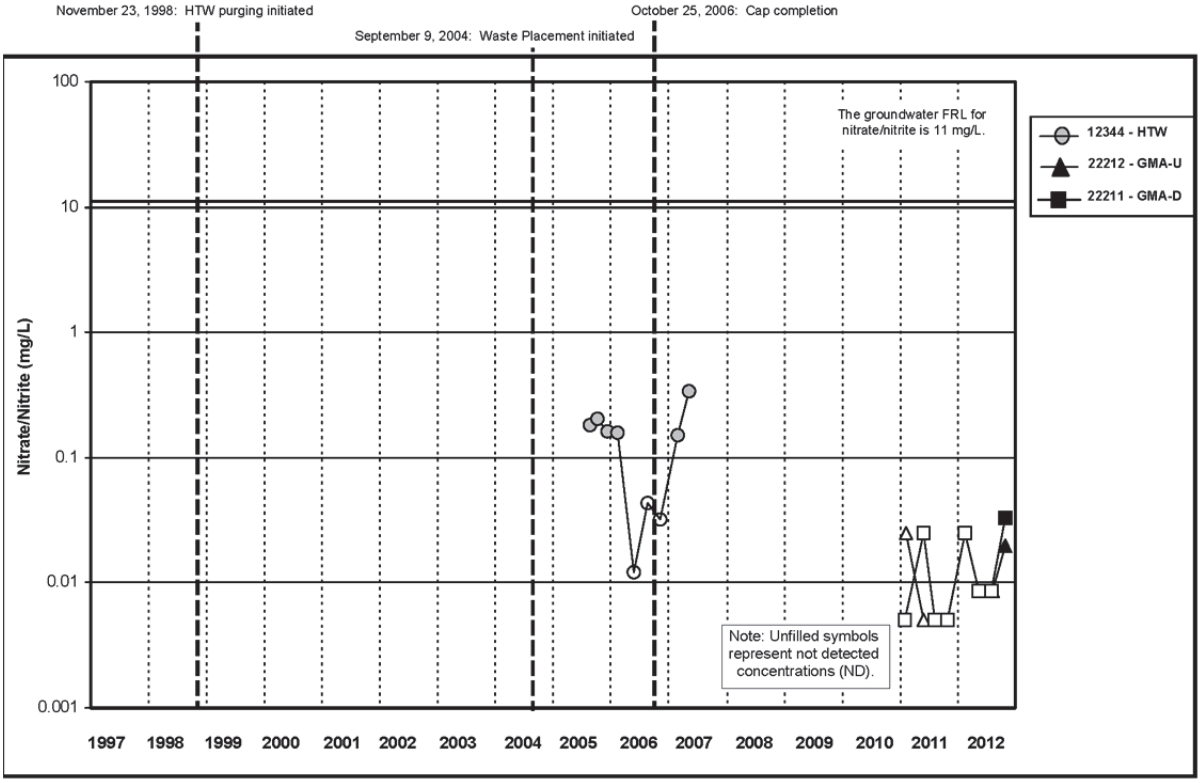


Figure A.5.7–9B. Cell 7 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

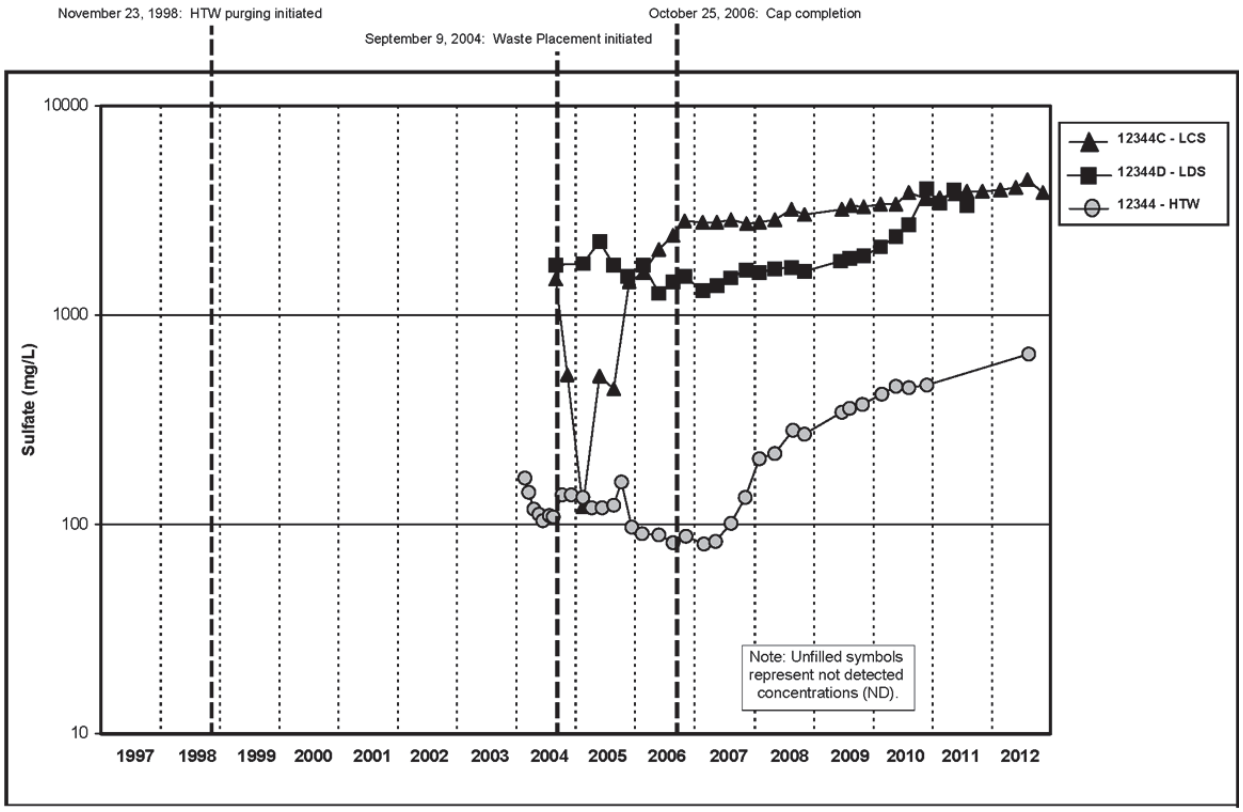


Figure A.5.7–10A. Cell 7 Sulfate Concentration vs. Time Plot for LCS, LDS, and HTW

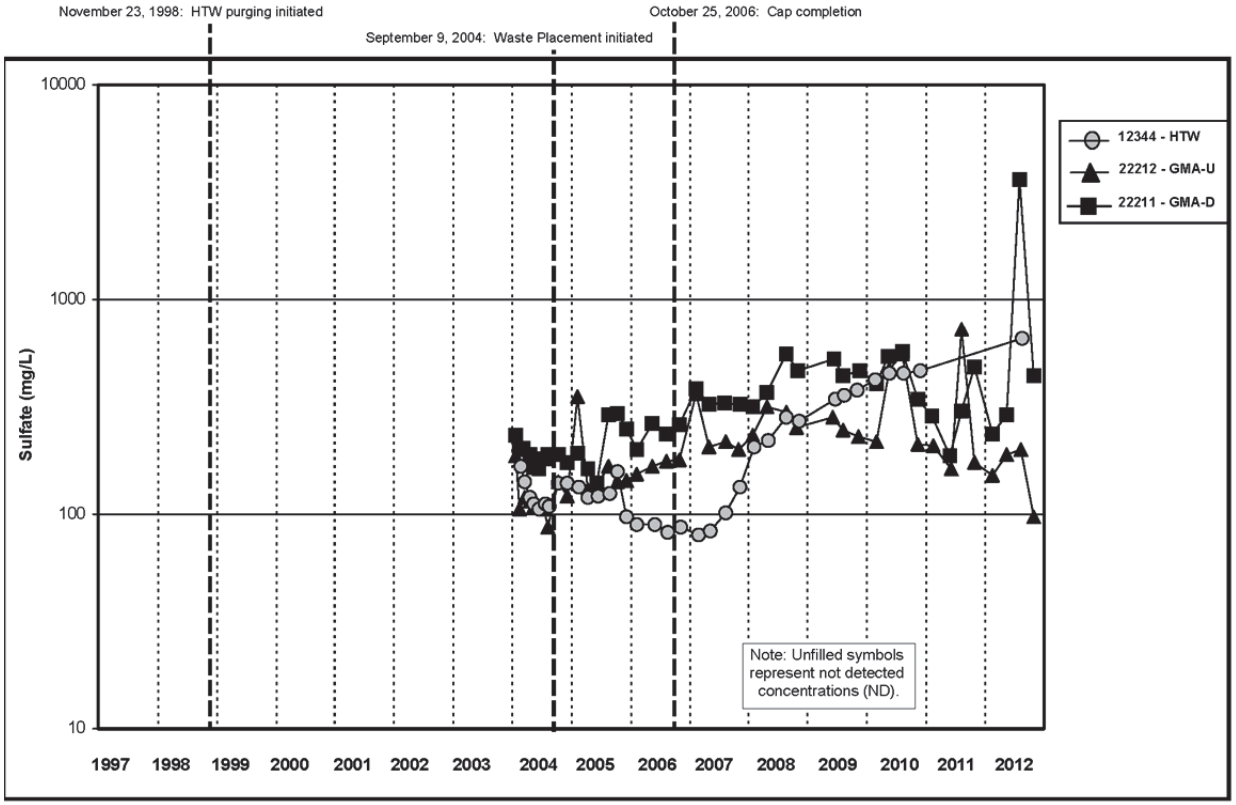


Figure A.5.7–10B. Cell 7 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

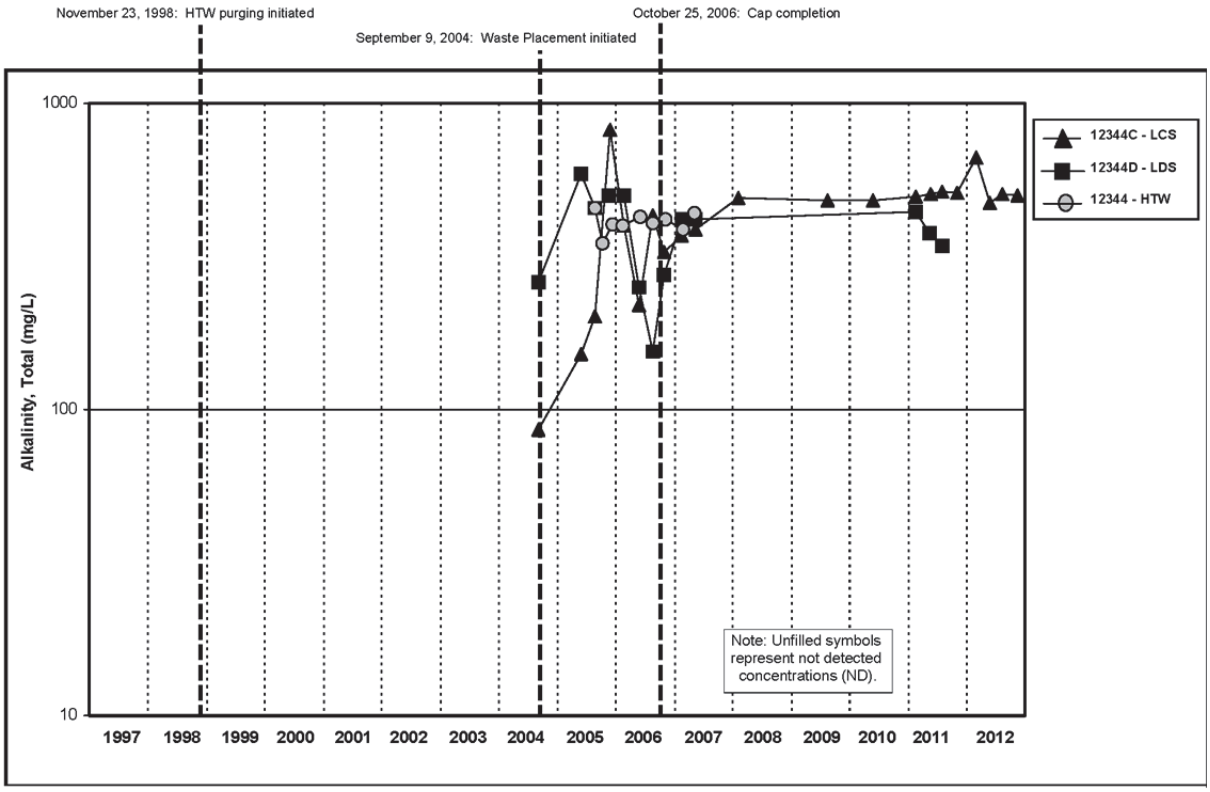


Figure A.5.7–11A. Cell 7 Alkalinity, Total Concentration vs. Time Plot for LCS, LDS, and HTW

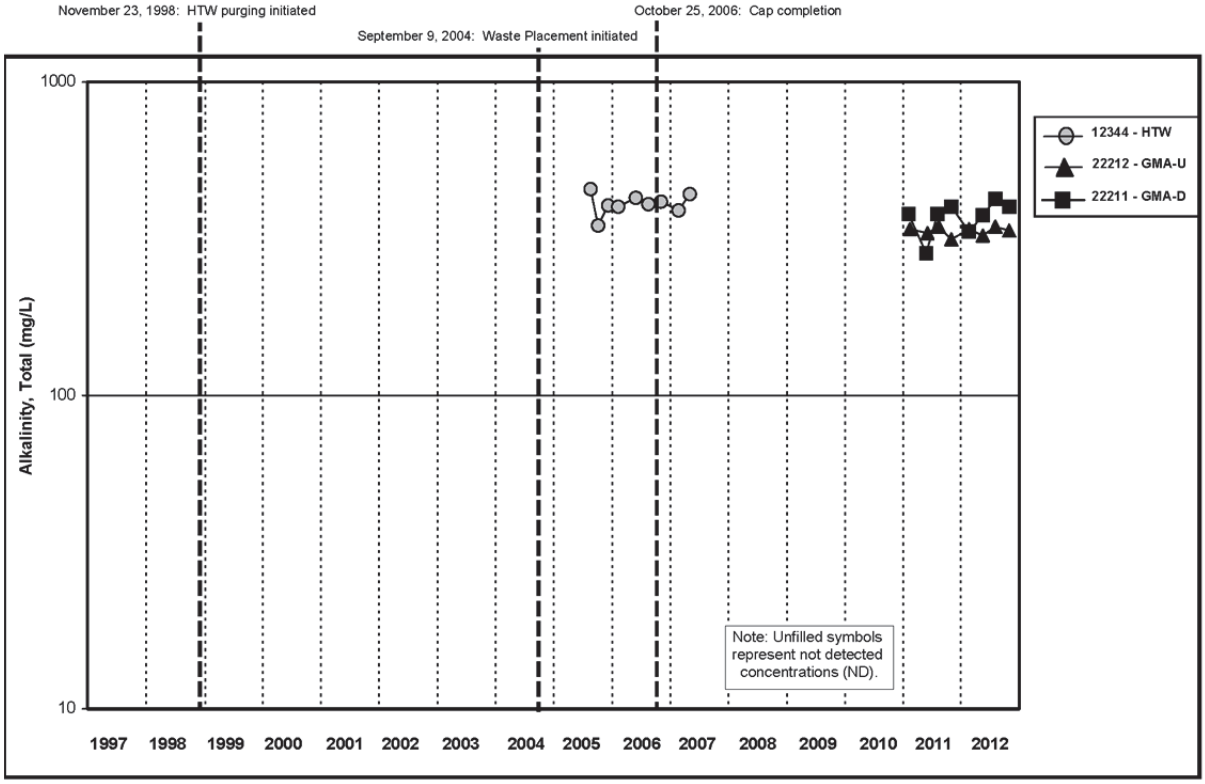


Figure A.5.7–11B. Cell 7 Alkalinity, Total Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

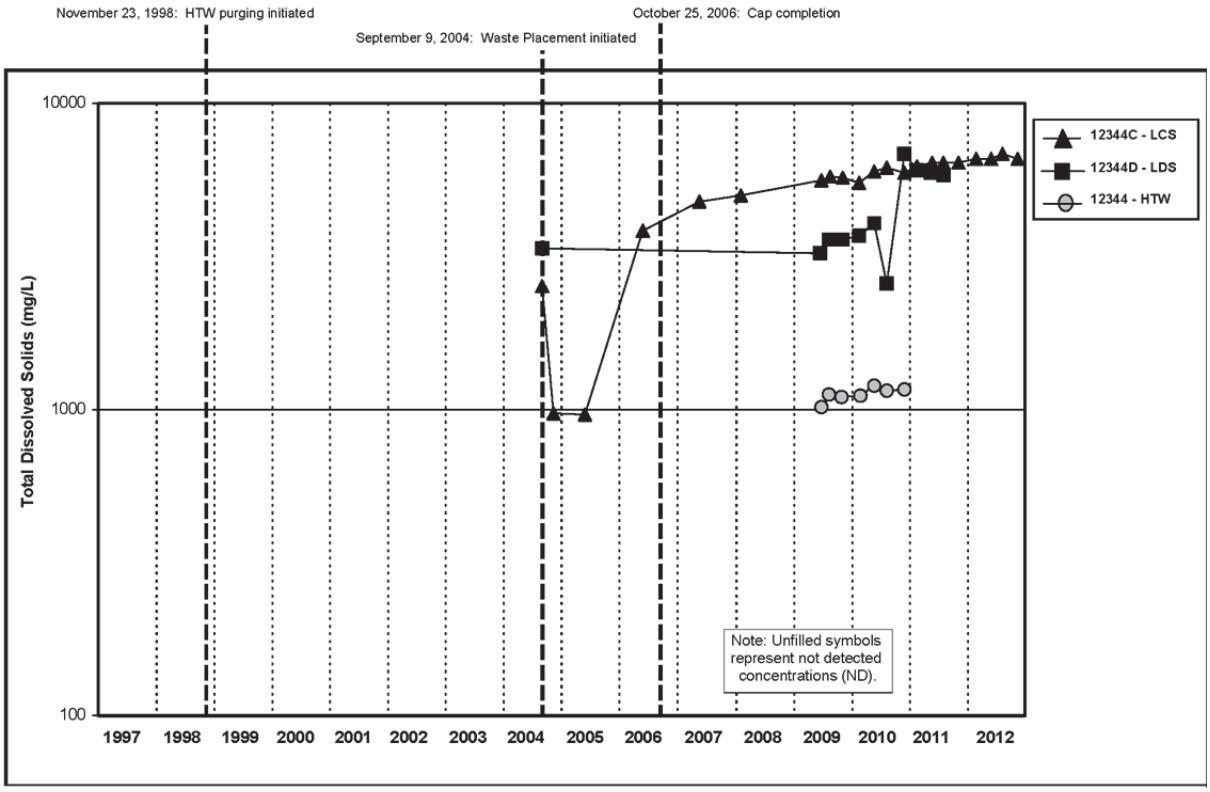


Figure A.5.7–12A. Cell 7 Total Dissolved Solids Concentration vs. Time Plot for LCS, LDS, and HTW

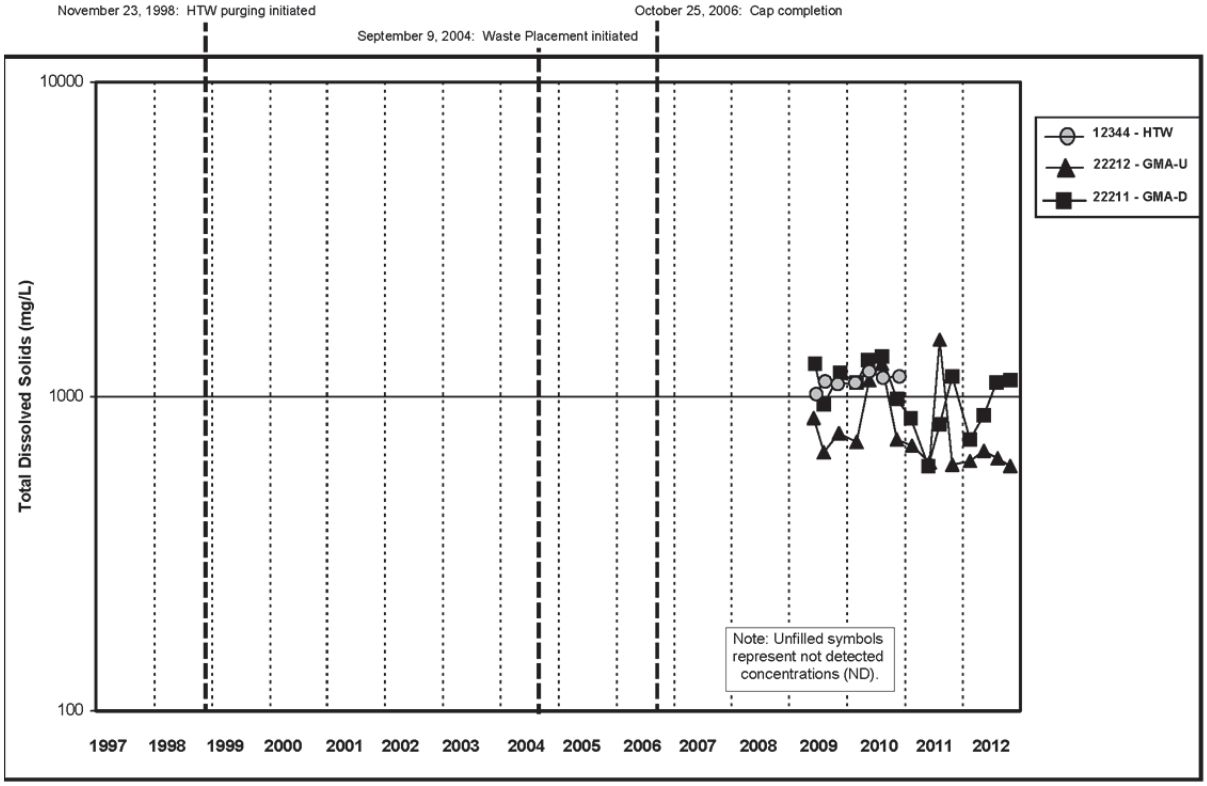


Figure A.5.7–12B. Cell 7 Total Dissolved Solids Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

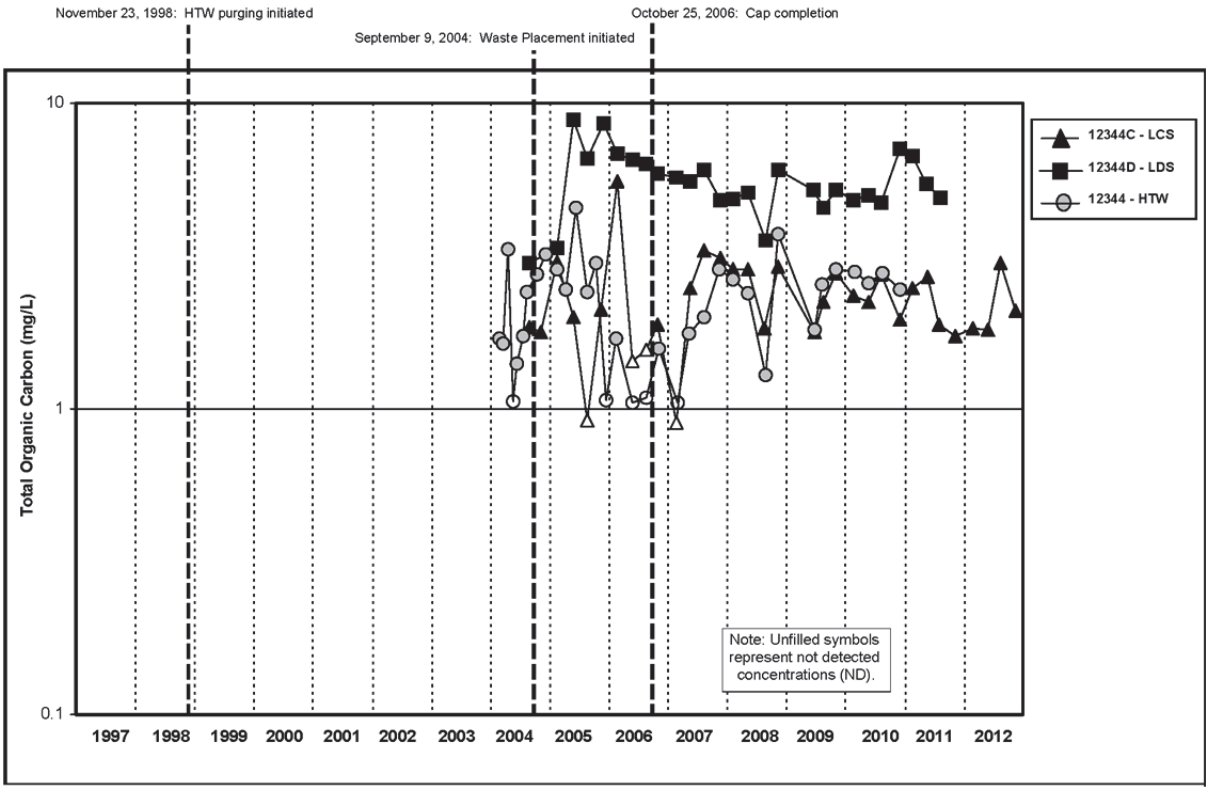


Figure A.5.7–13A. Cell 7 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, and HTW

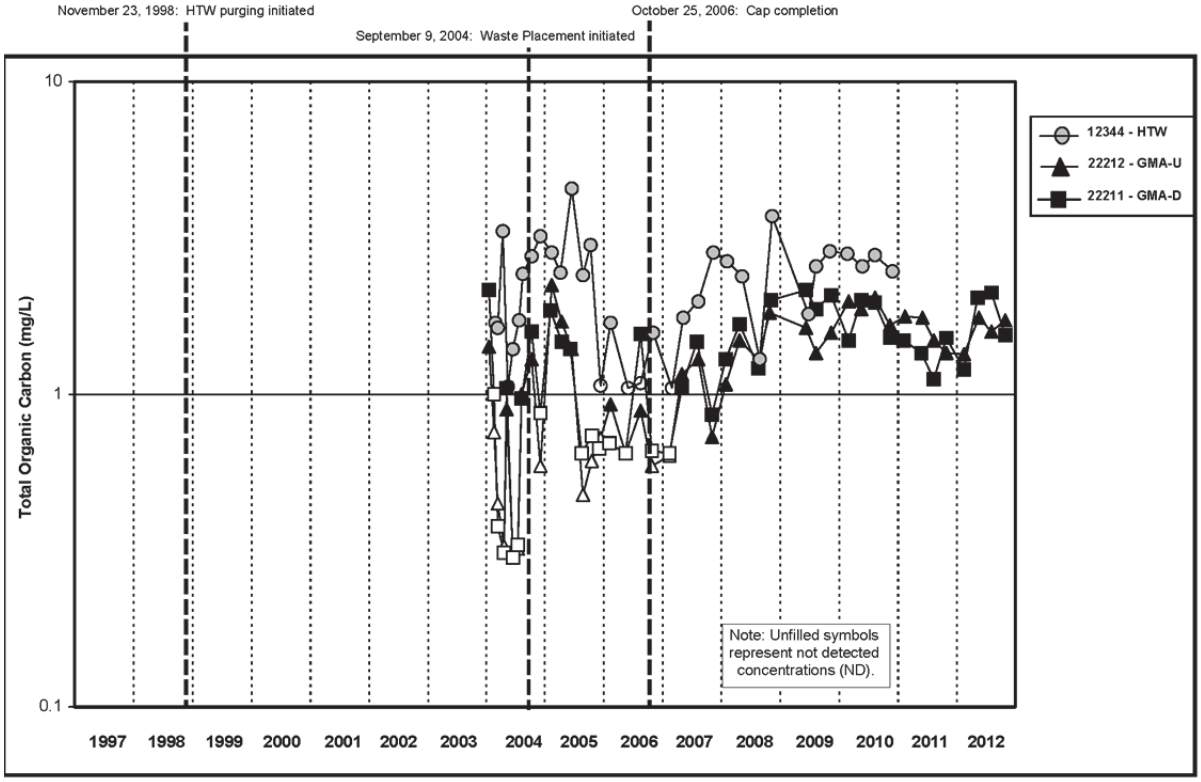


Figure A.5.7–13B. Cell 7 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

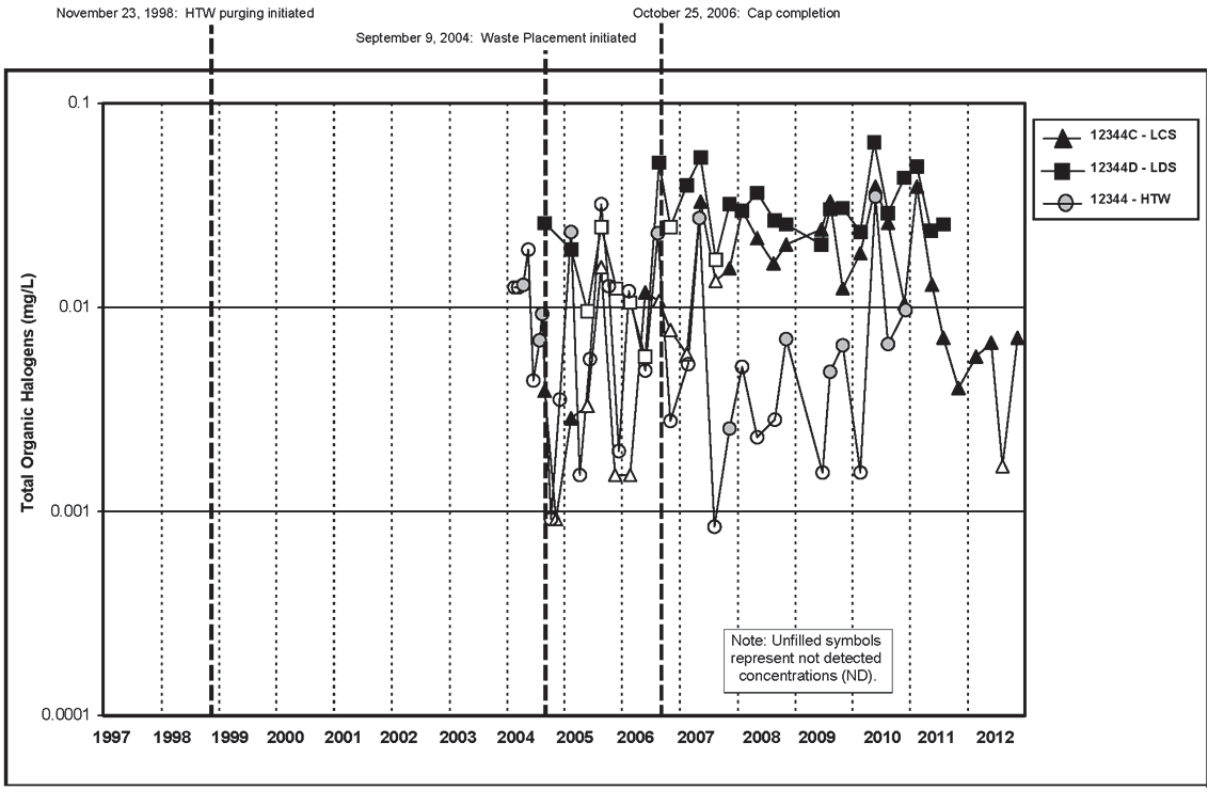


Figure A.5.7–14A. Cell 7 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, and HTW

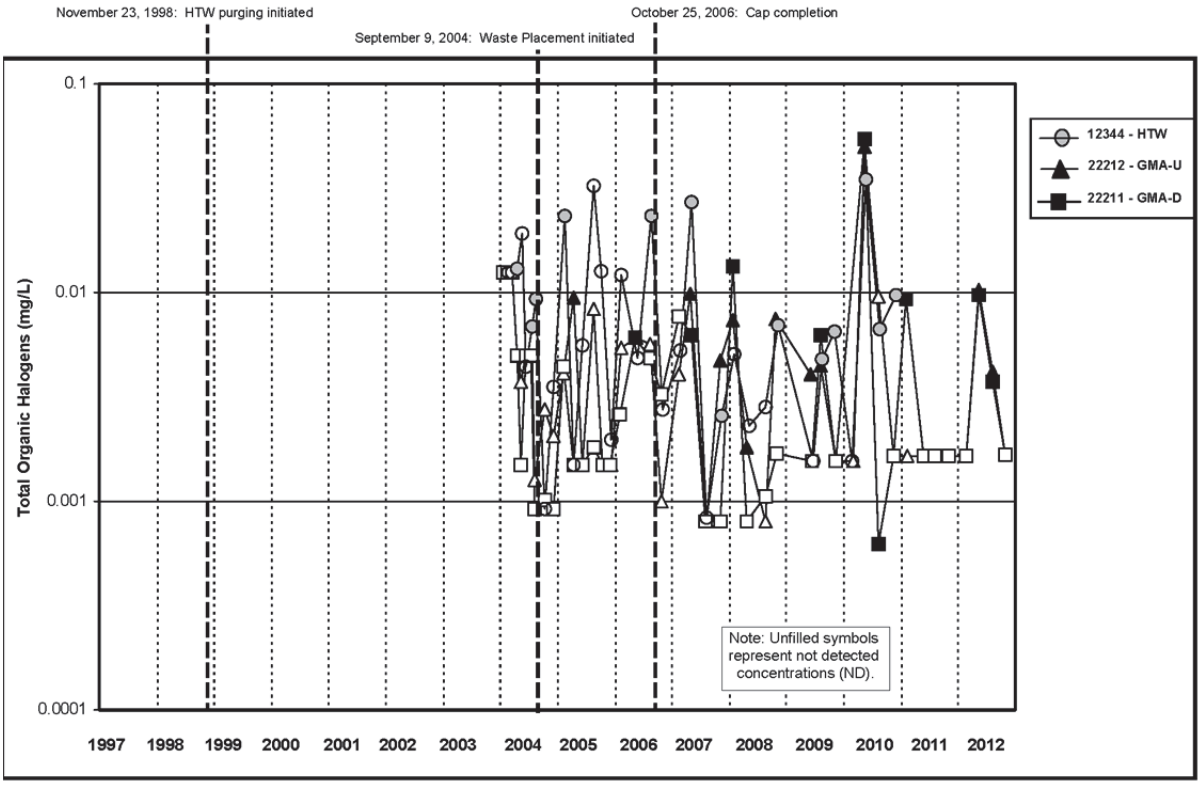


Figure A.5.7–14B. Cell 7 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

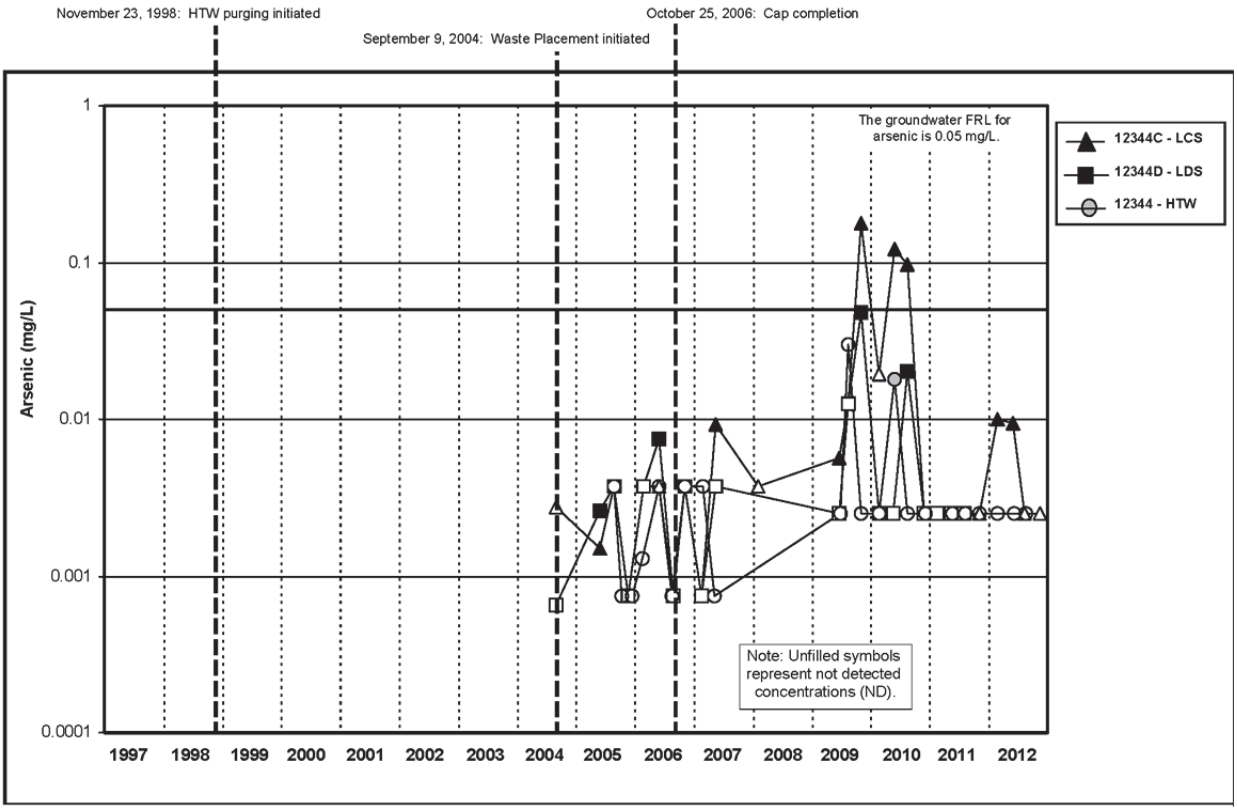


Figure A.5.7–15A. Cell 7 Arsenic Concentration vs. Time Plot for LCS, LDS, and HTW

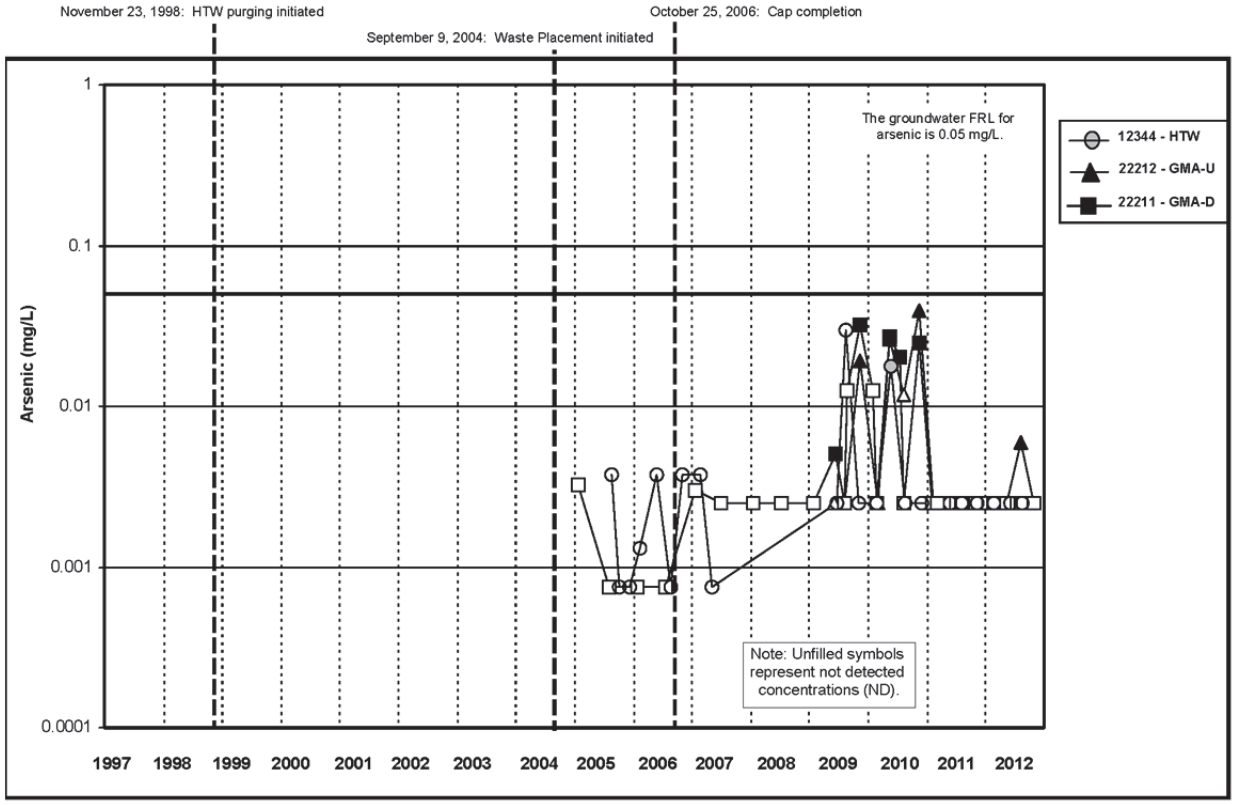


Figure A.5.7–15B. Cell 7 Arsenic Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

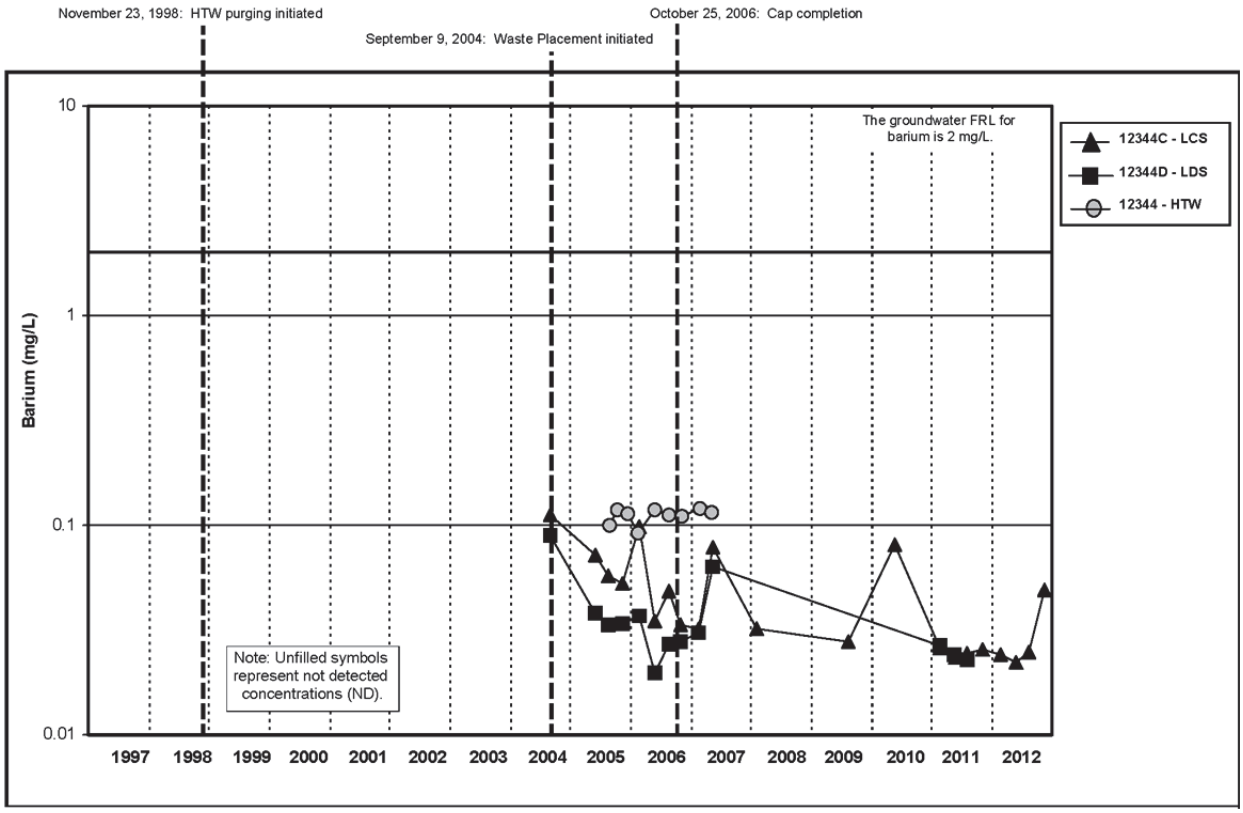


Figure A.5.7–16A. Cell 7 Barium Concentration vs. Time Plot for LCS, LDS, and HTW

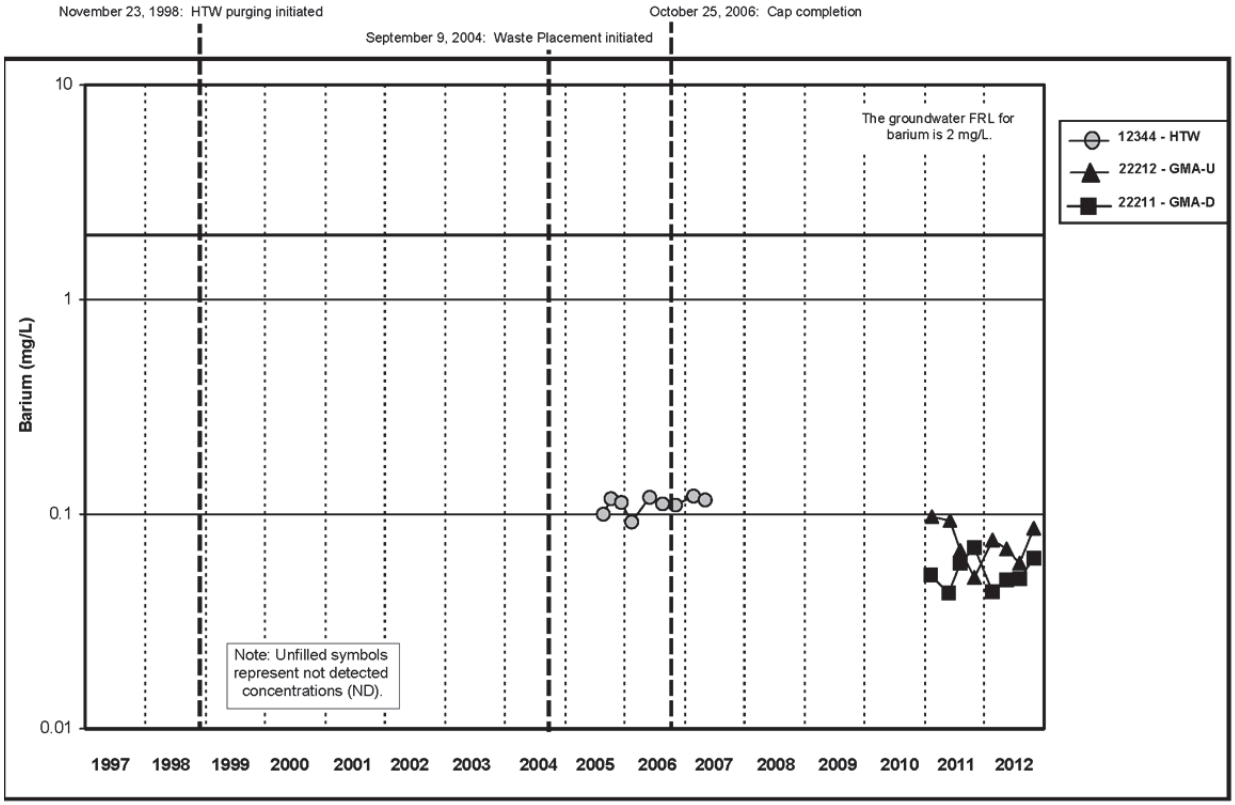


Figure A.5.7–16B. Cell 7 Barium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

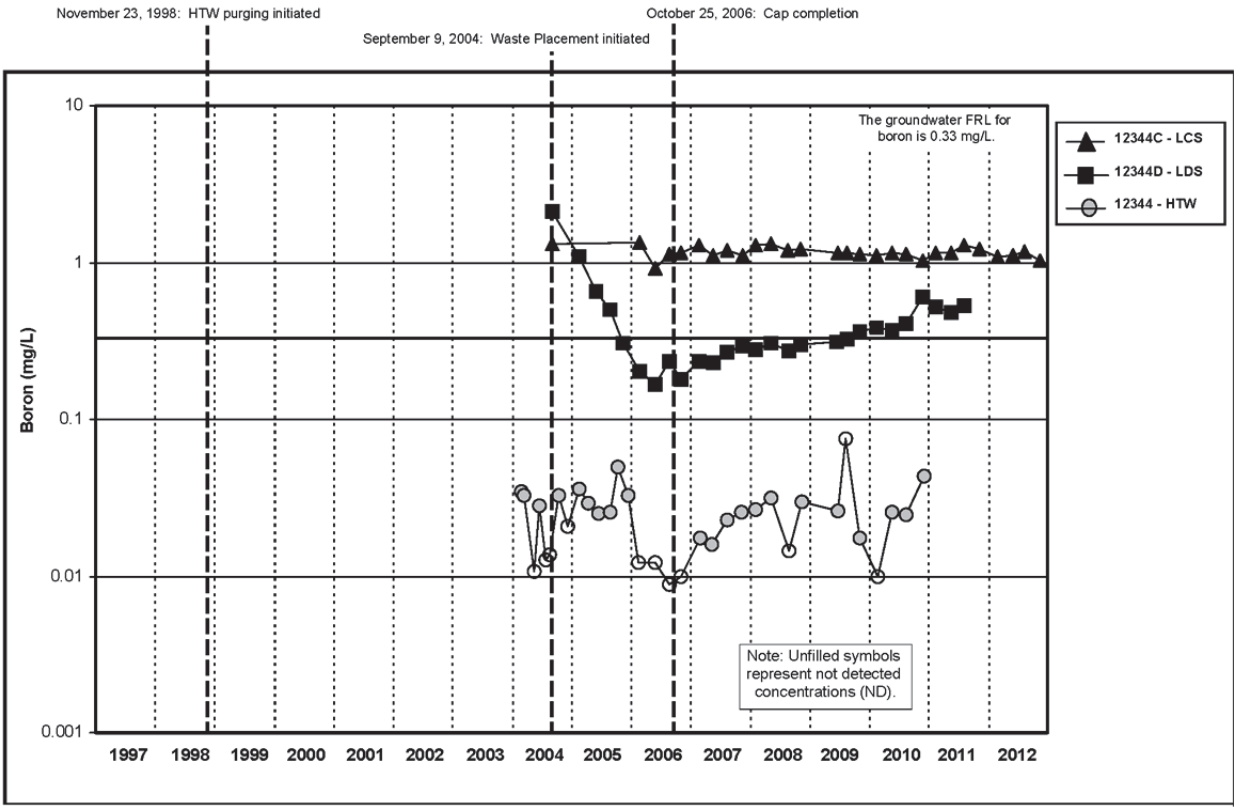


Figure A.5.7–17A. Cell 7 Boron Concentration vs. Time Plot for LCS, LDS, and HTW

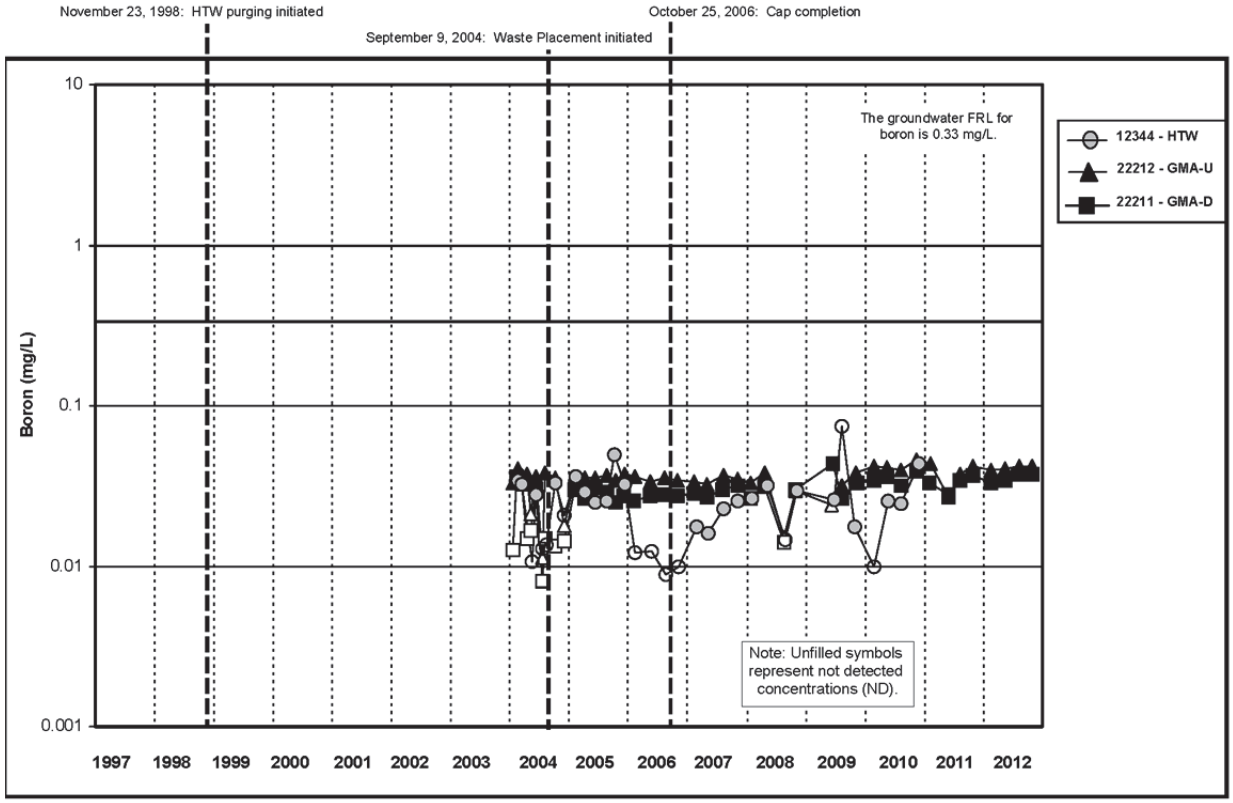


Figure A.5.7–17B. Cell 7 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

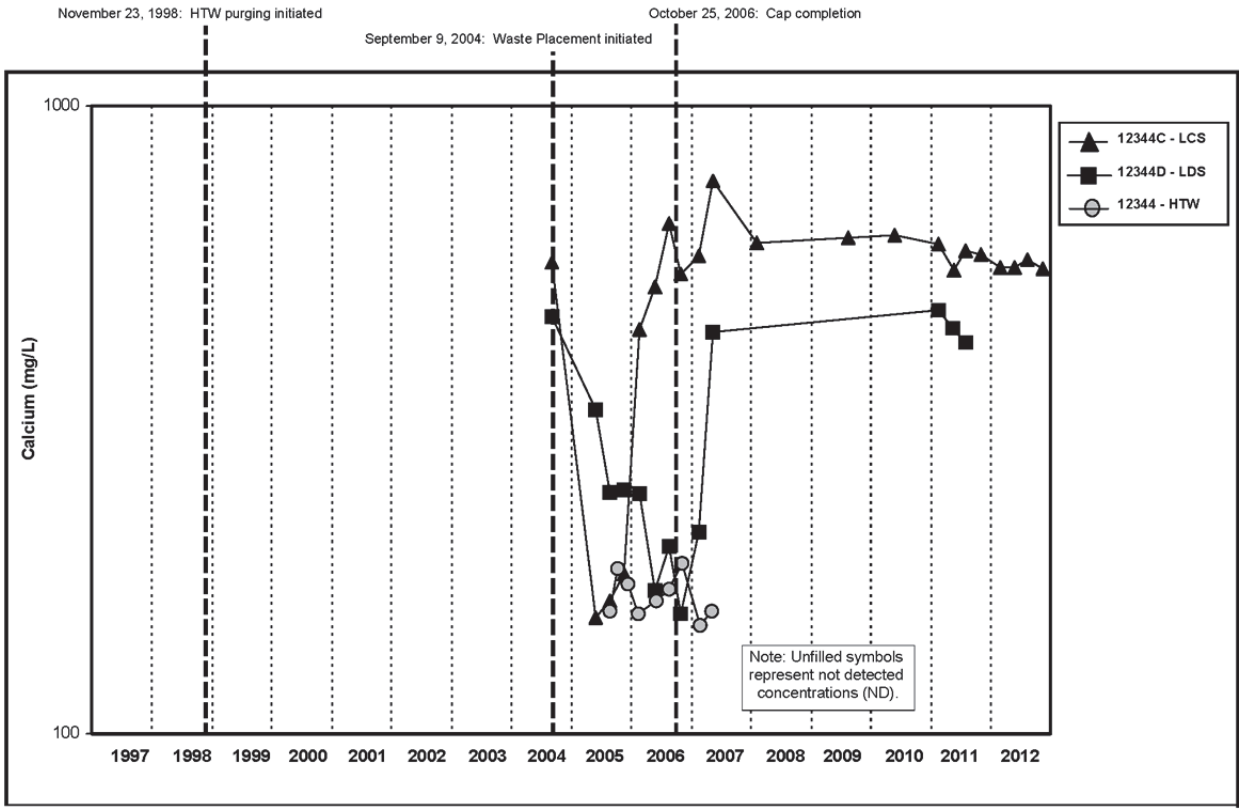


Figure A.5.7–18A. Cell 7 Calcium Concentration vs. Time Plot for LCS, LDS, and HTW

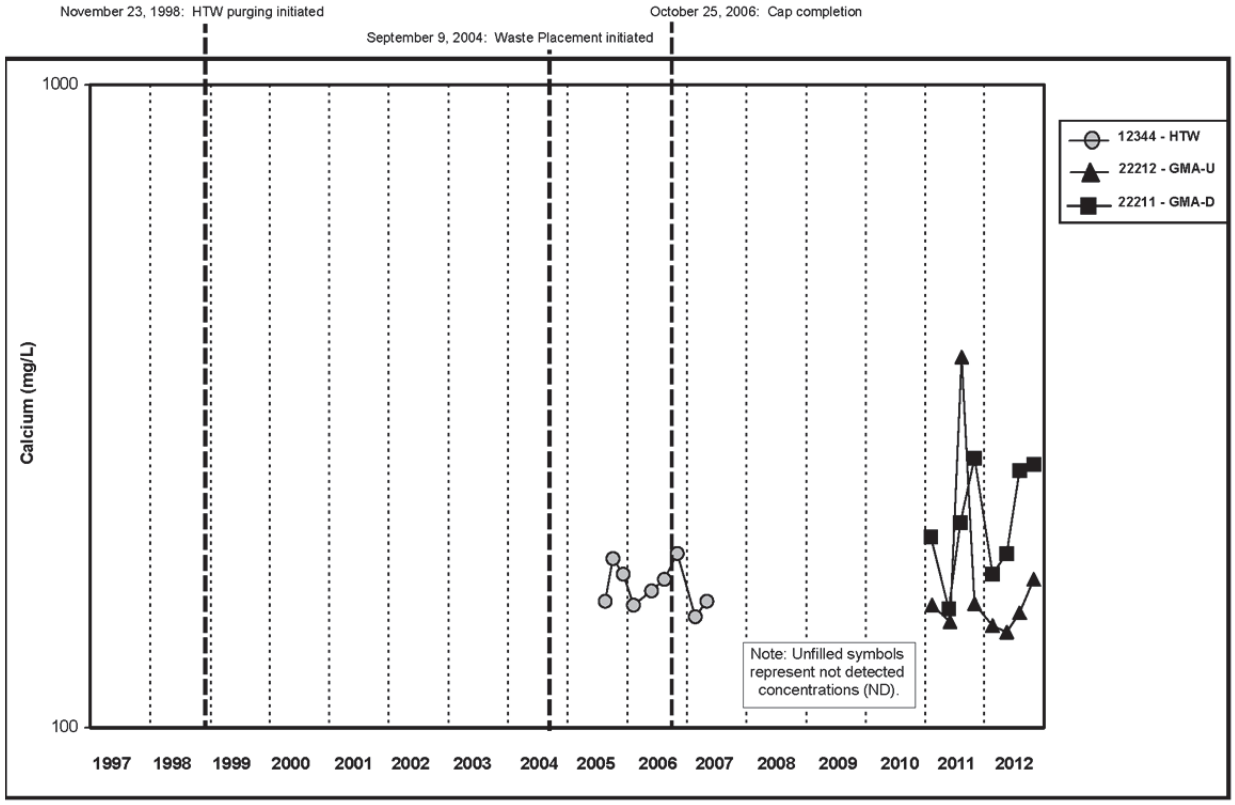
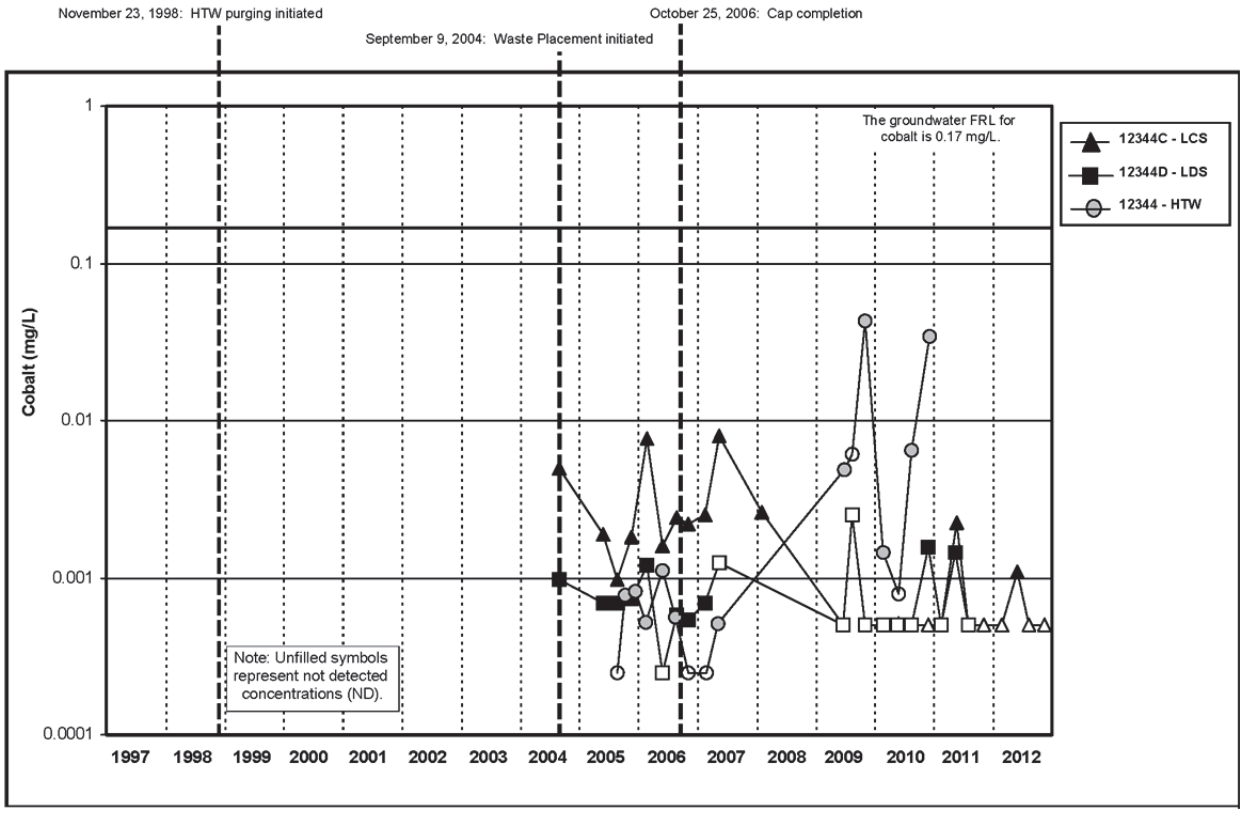


Figure A.5.7–18B. Cell 7 Calcium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well



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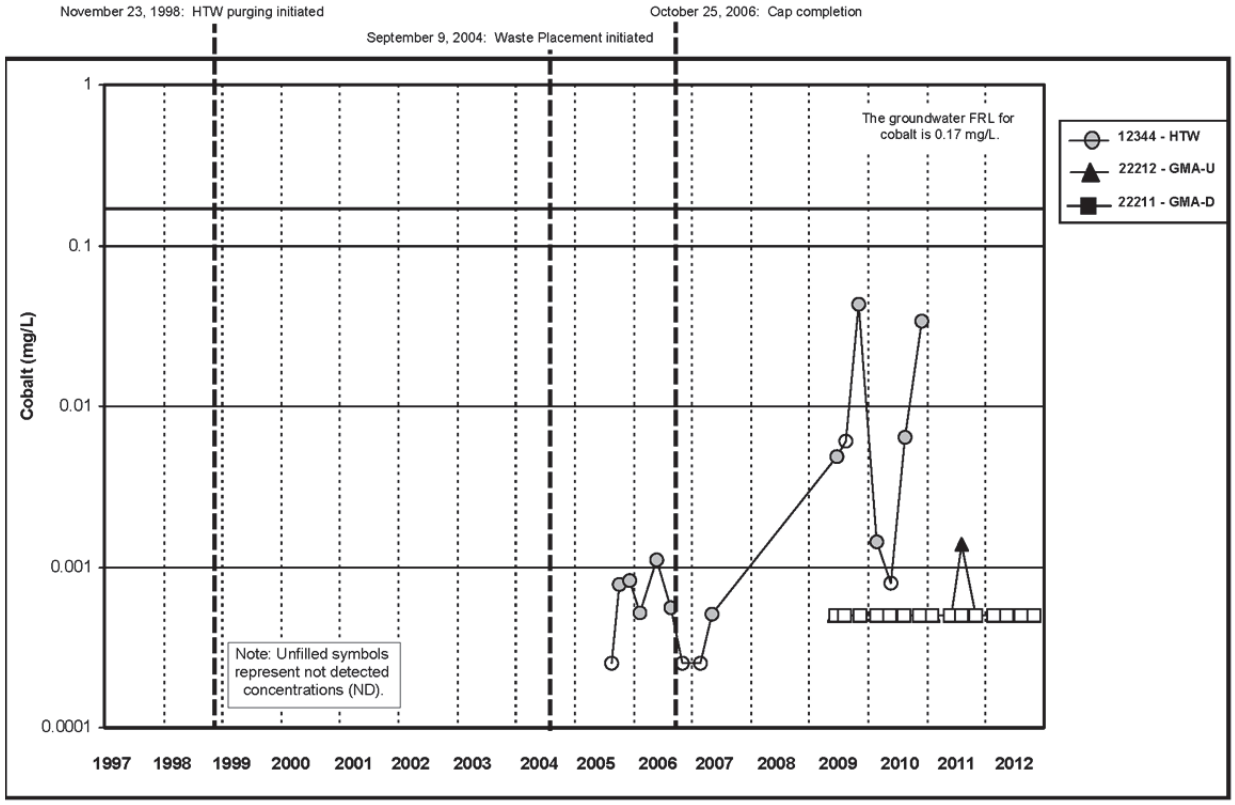

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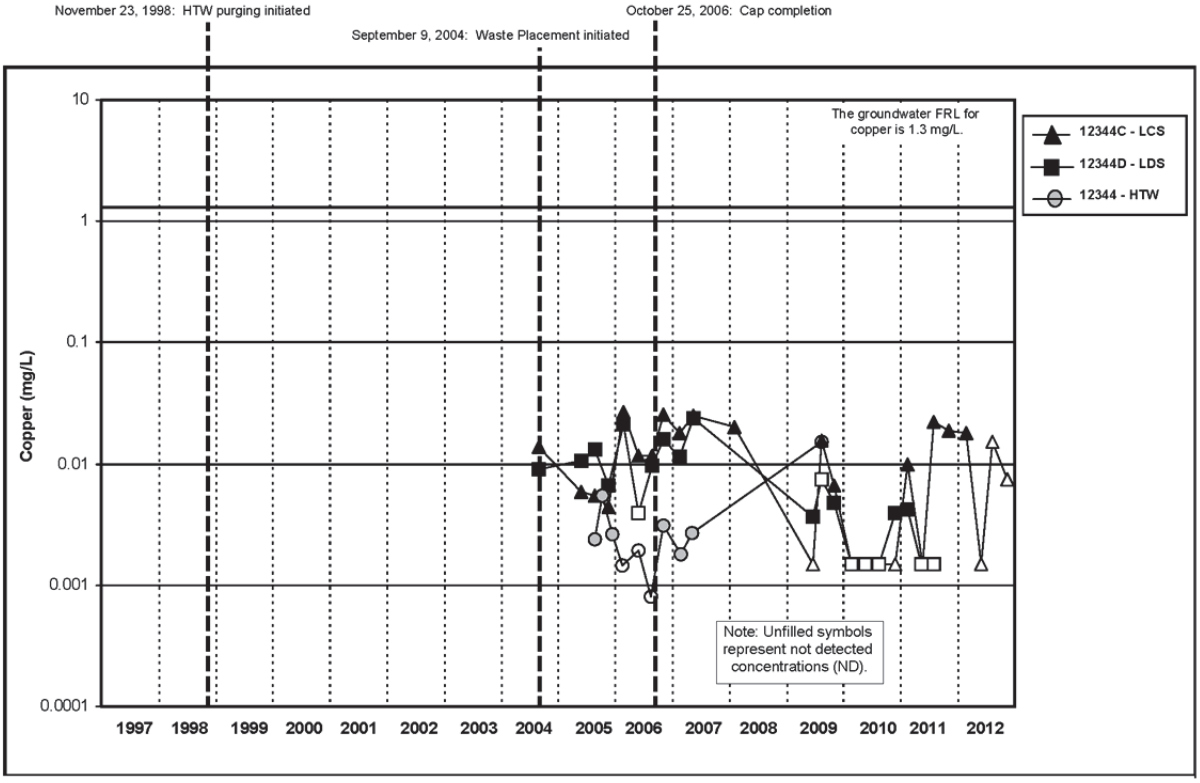

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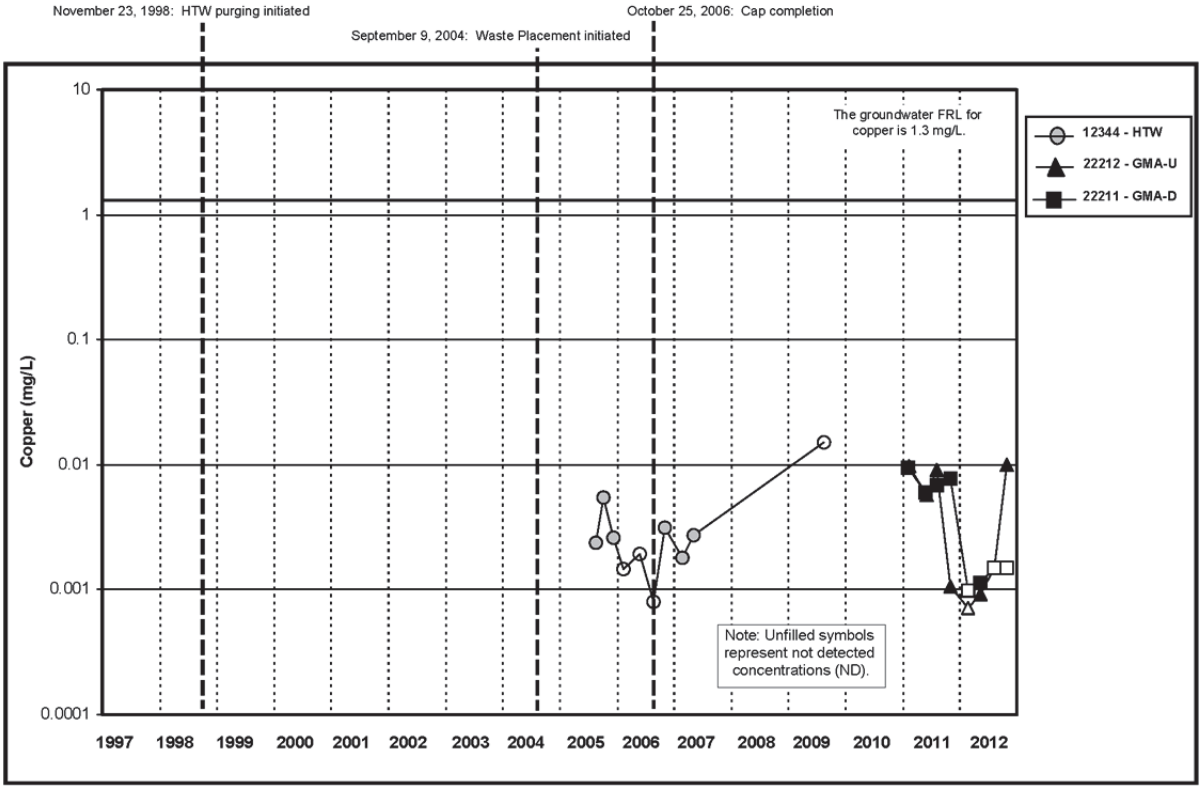

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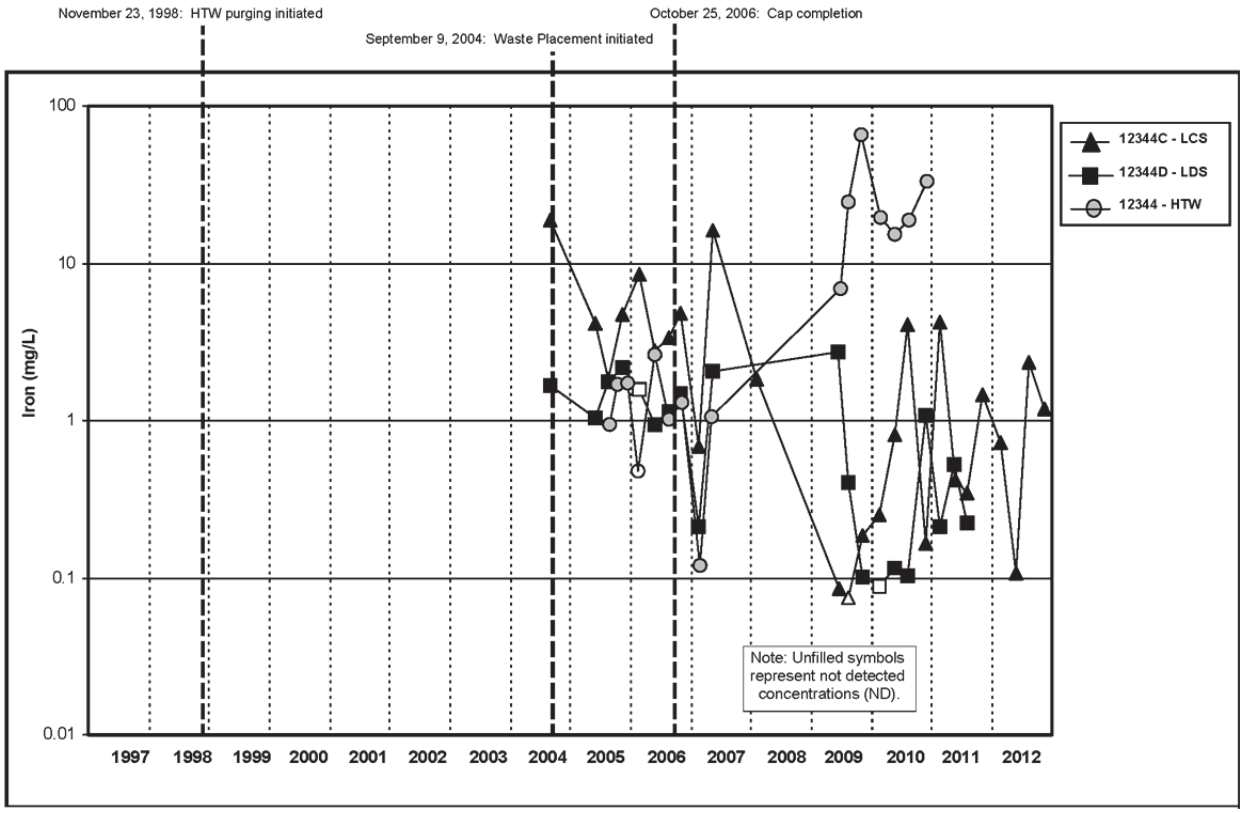

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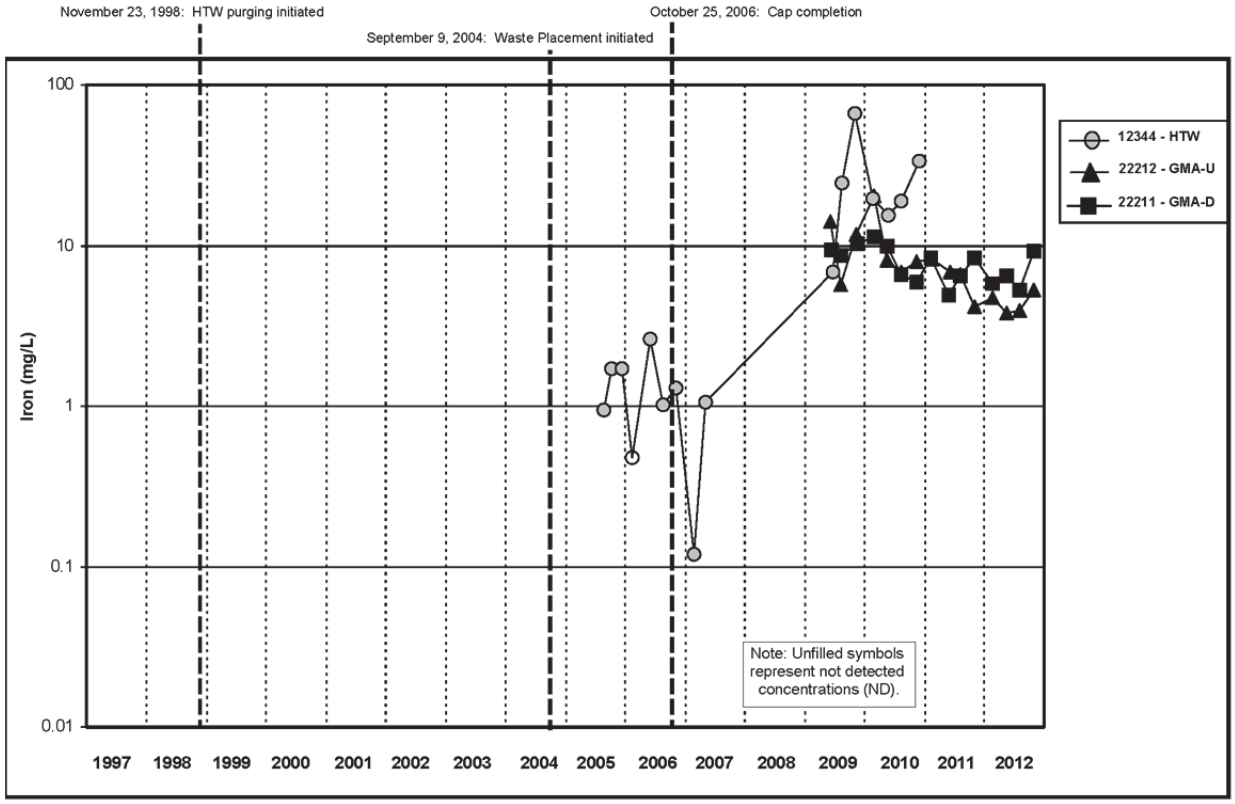

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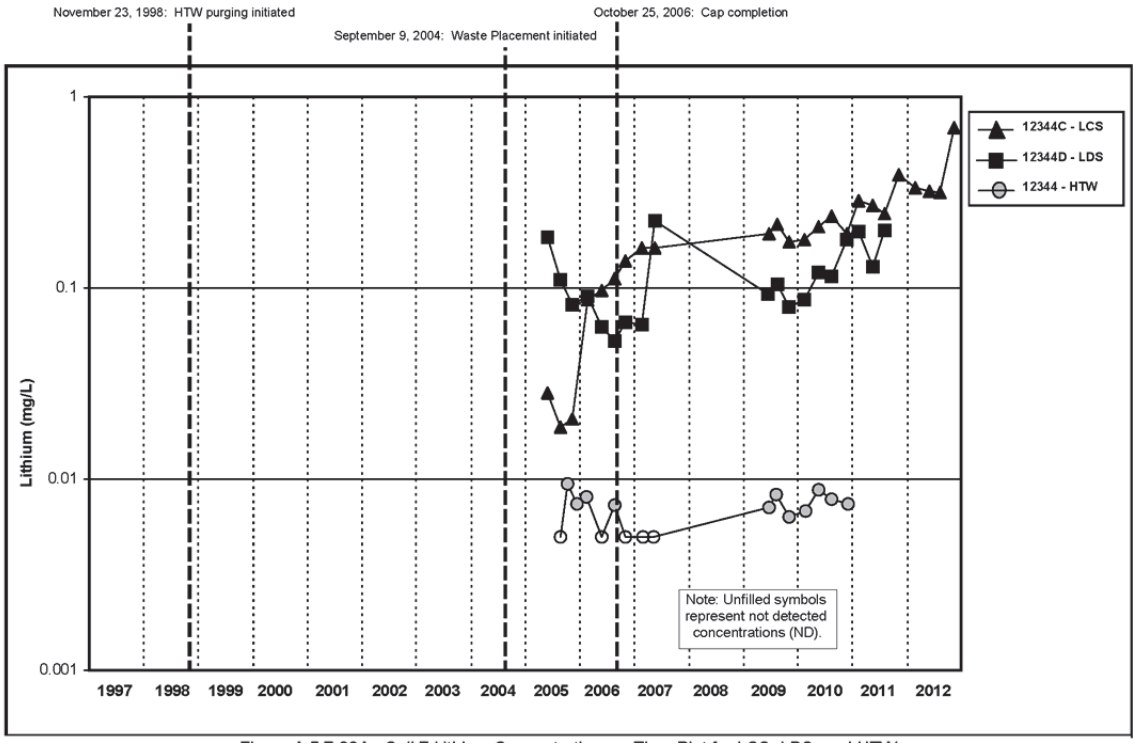
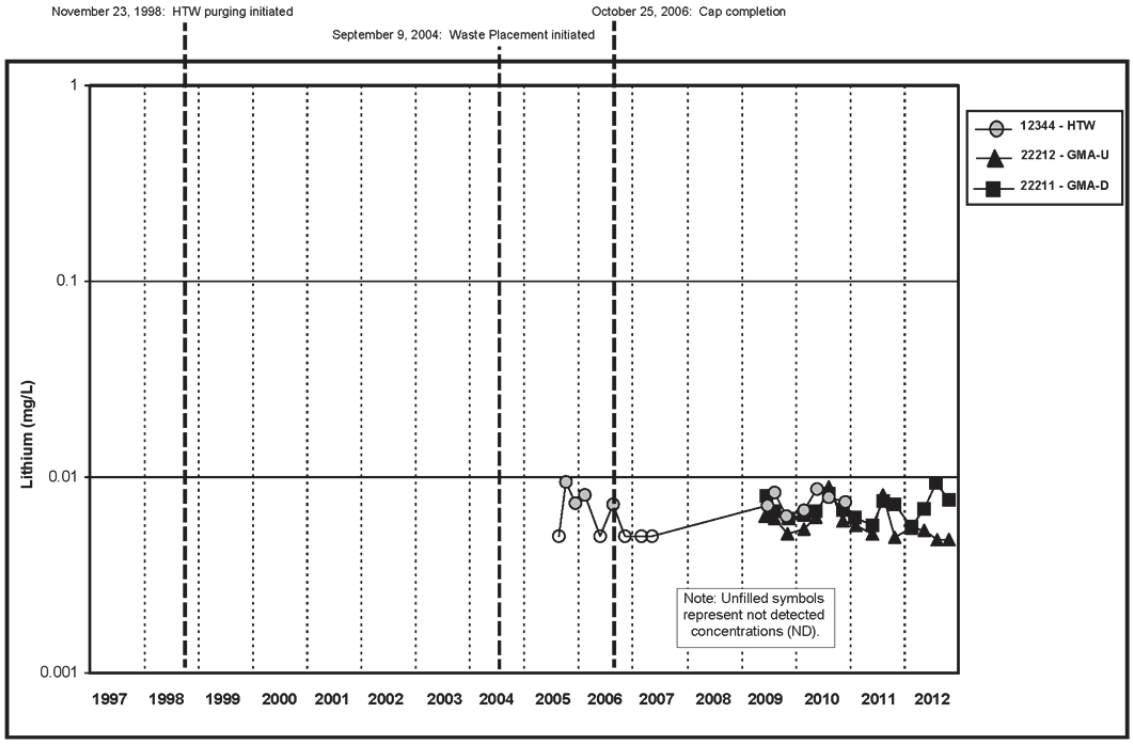


Figure A.5.7–22A. Cell 7 Lithium Concentration vs. Time Plot for LCS, LDS, and HTW



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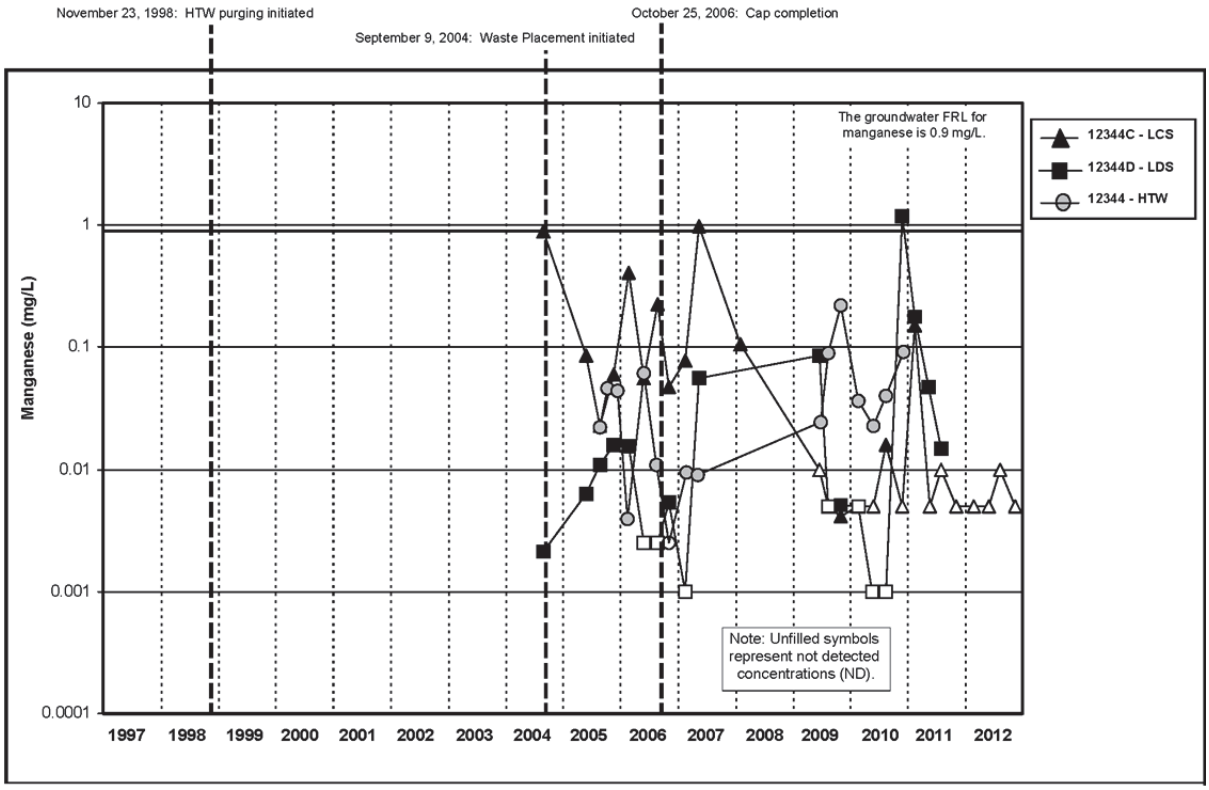

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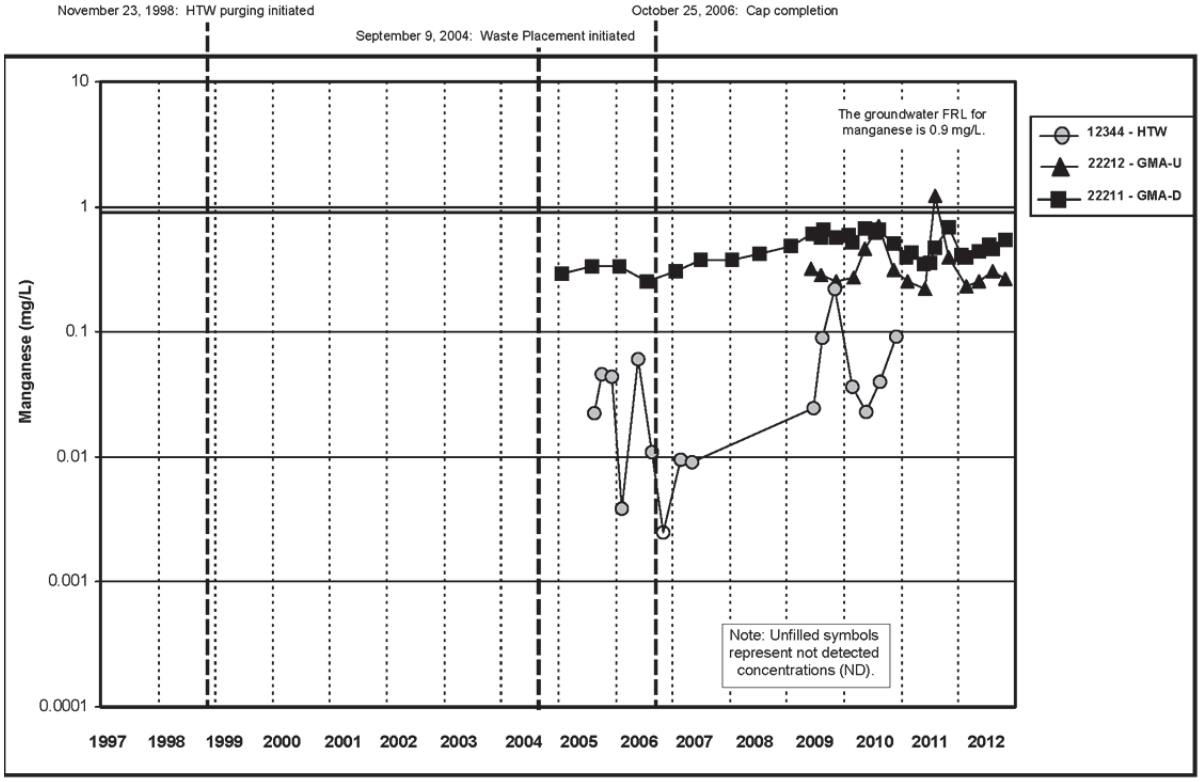

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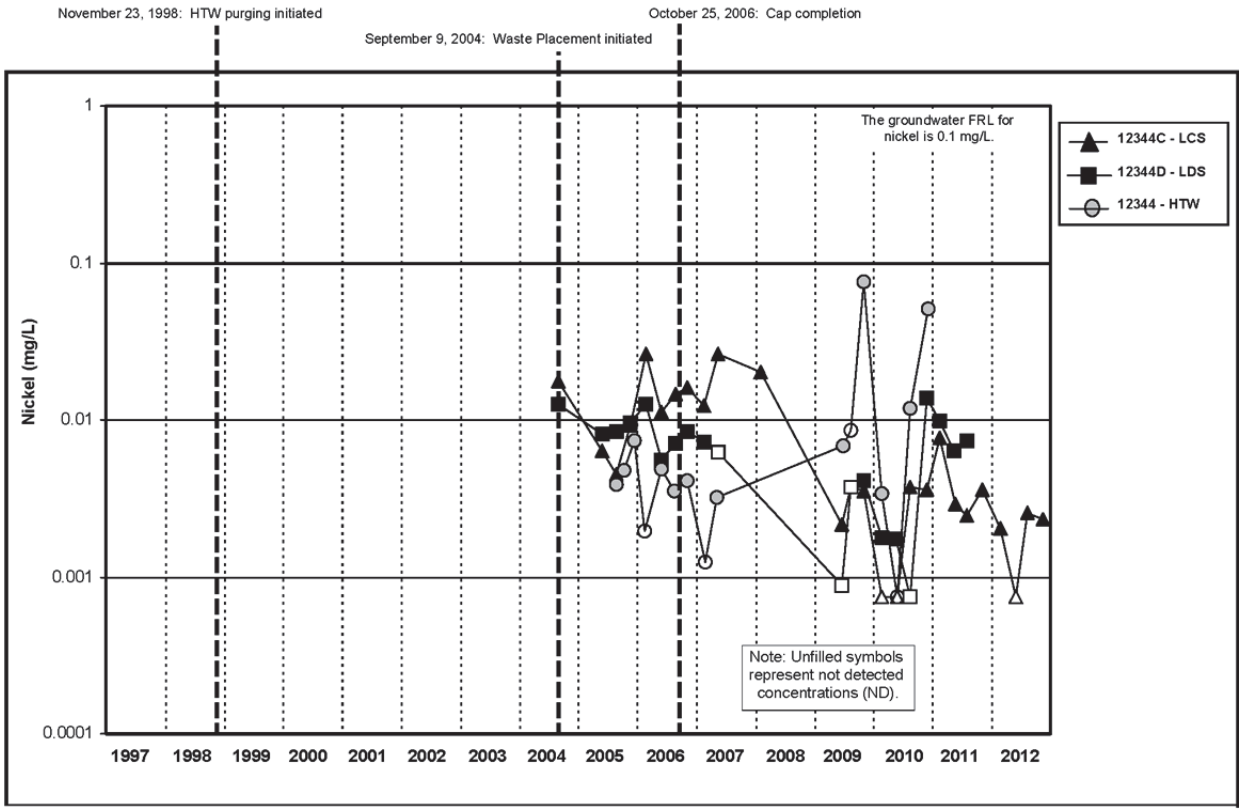

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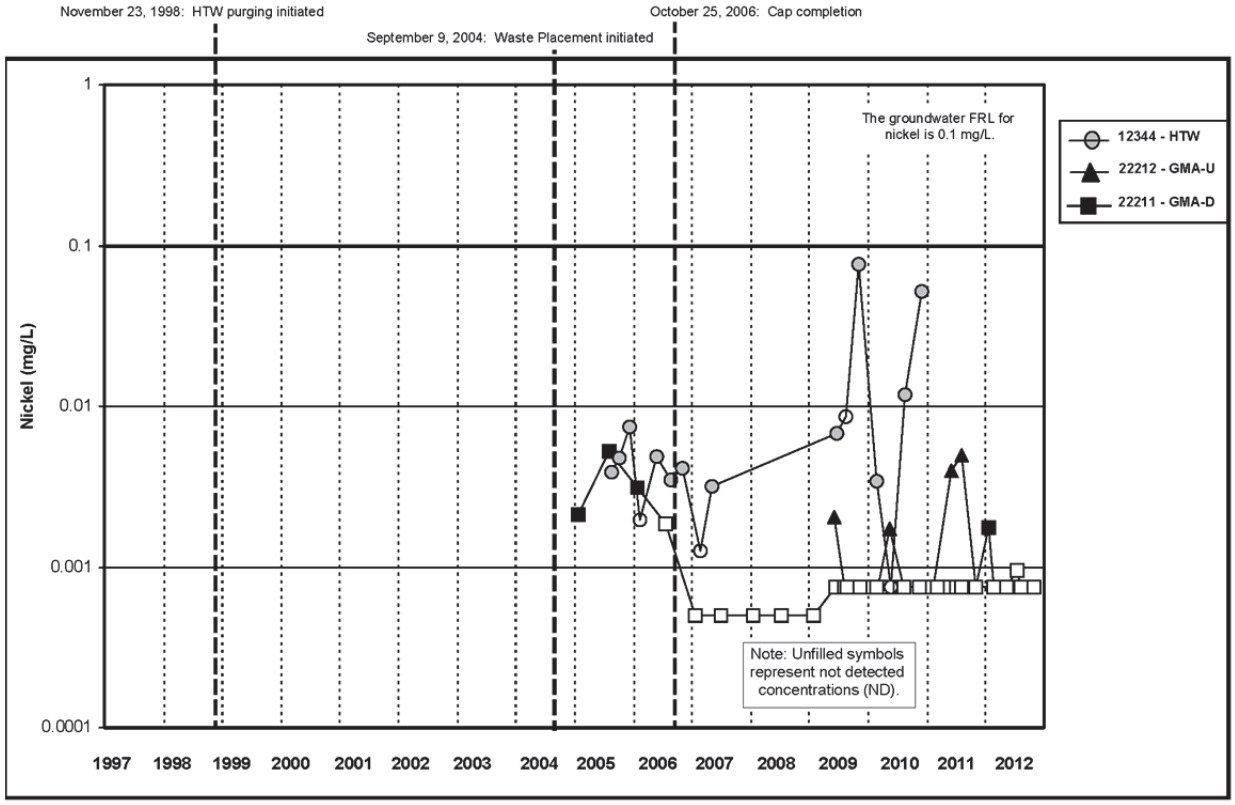

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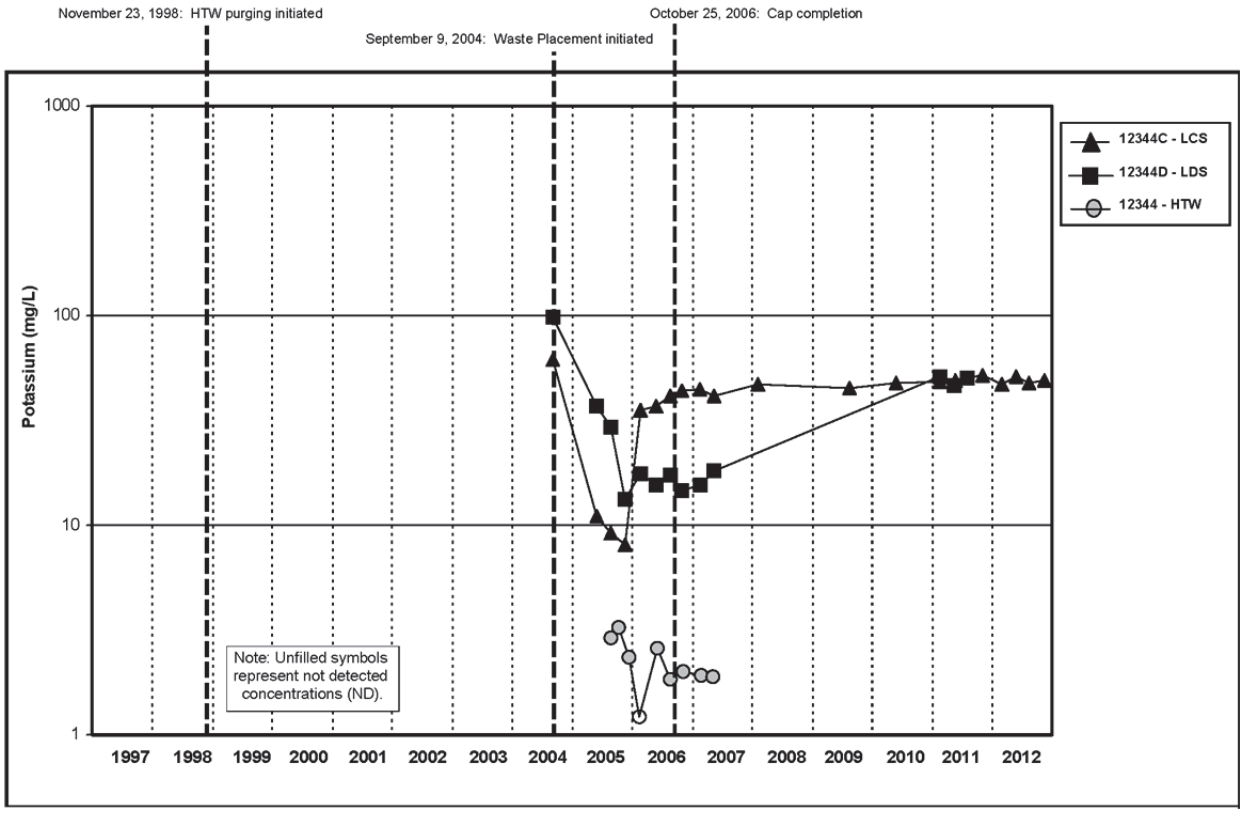

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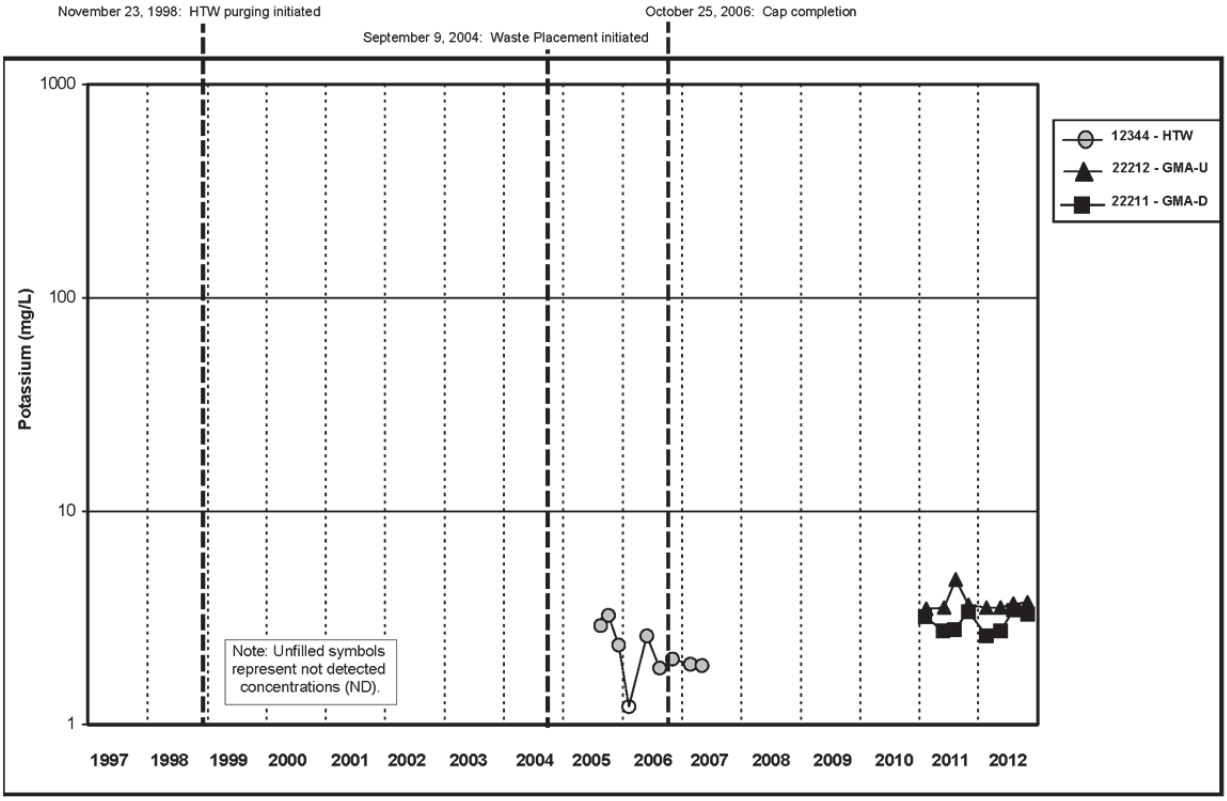
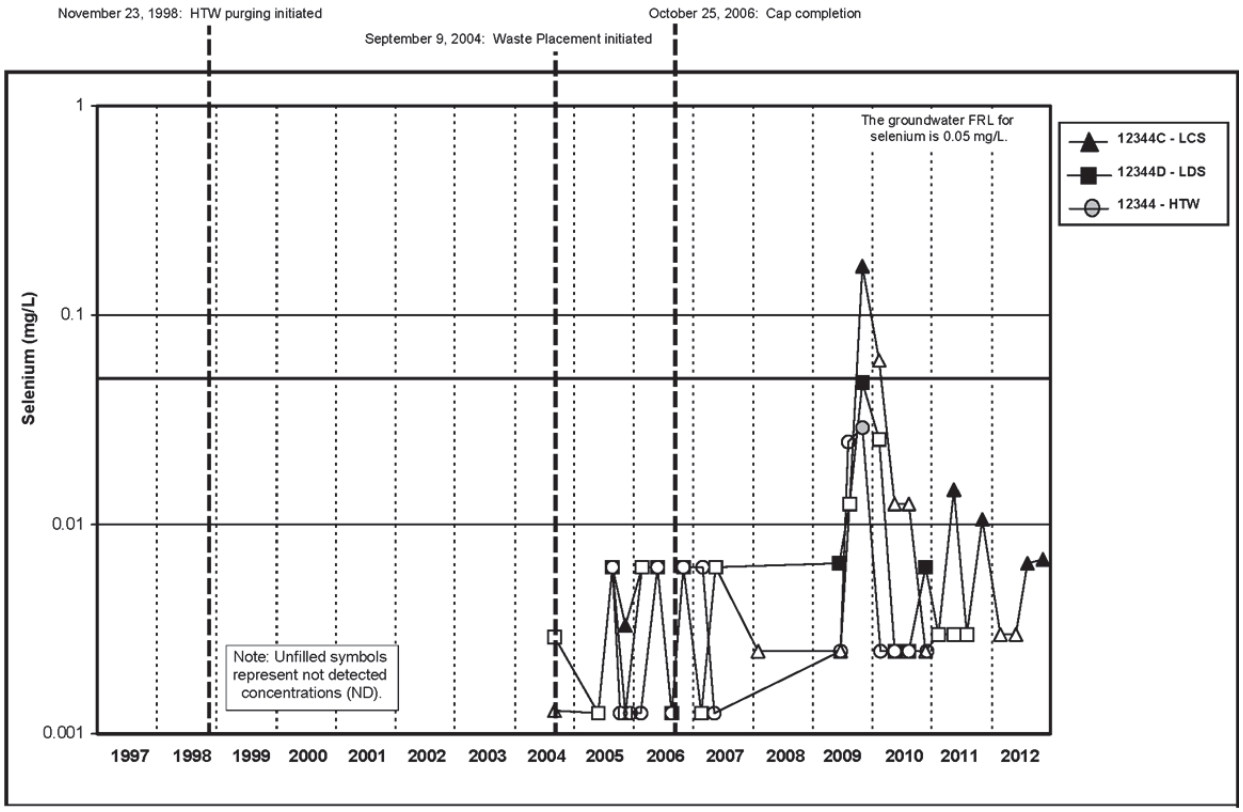


Figure A.5.7–25B. Cell 7 Potassium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well



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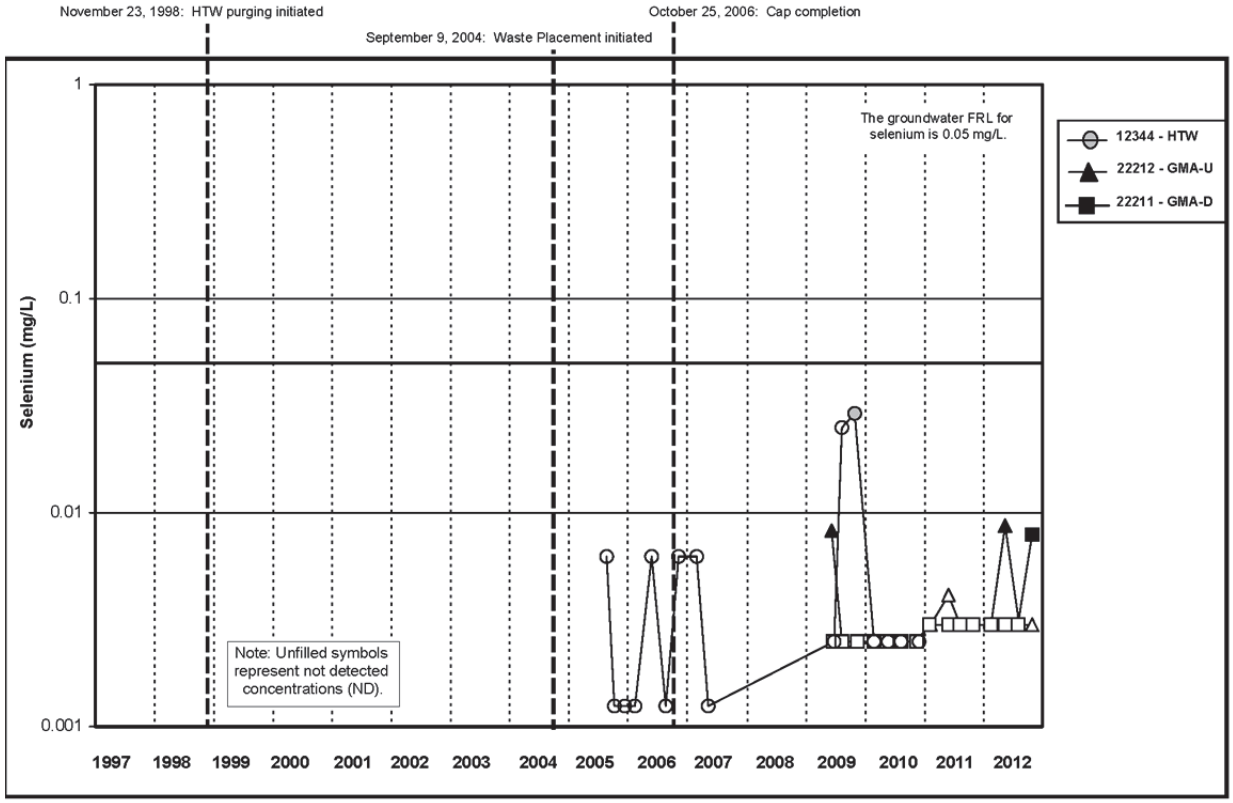

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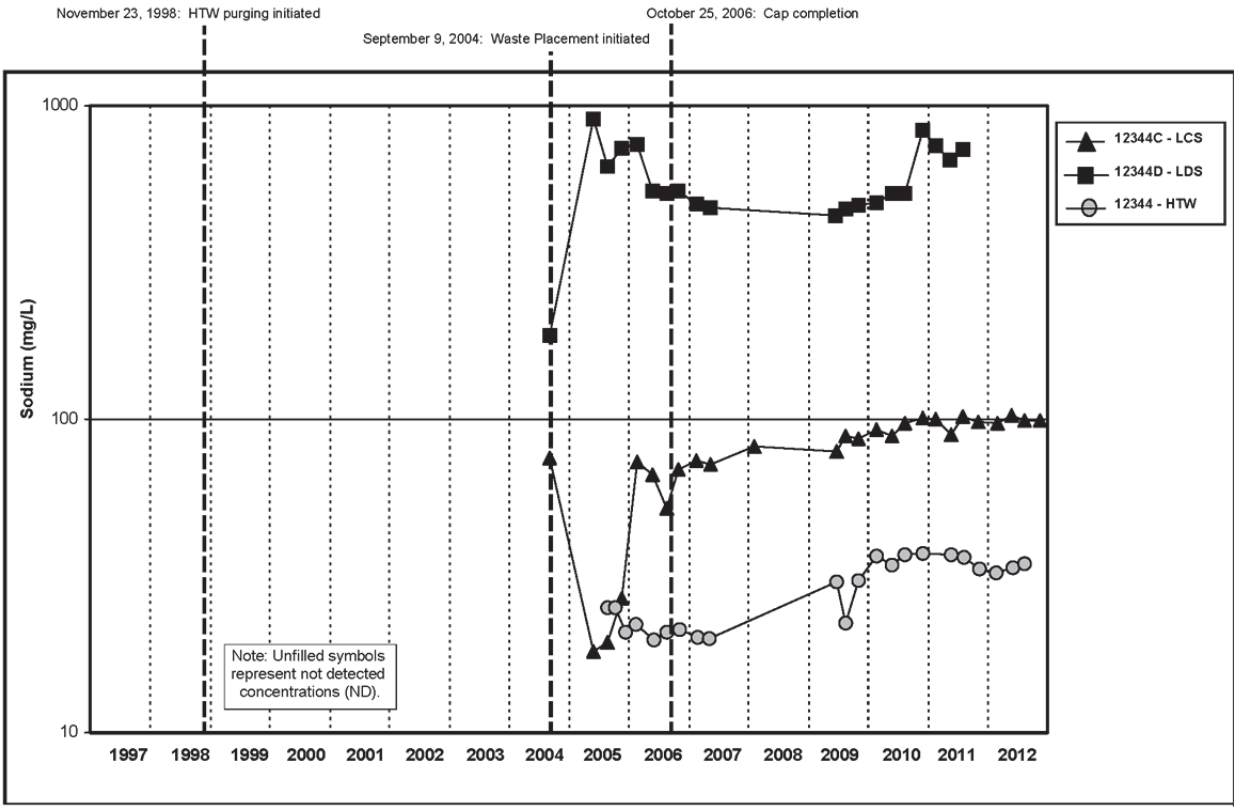
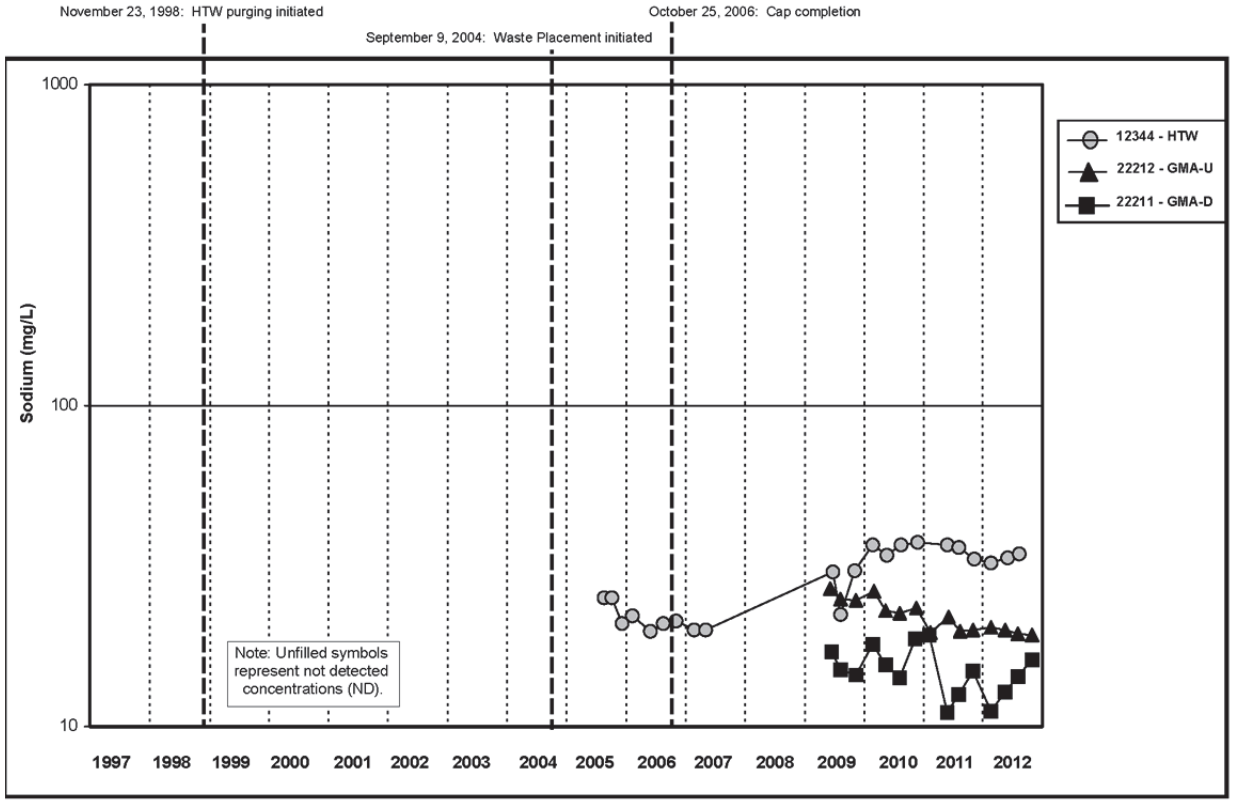


Figure A.5.7–27A. Cell 7 Sodium Concentration vs. Time Plot for LCS, LDS, and HTW



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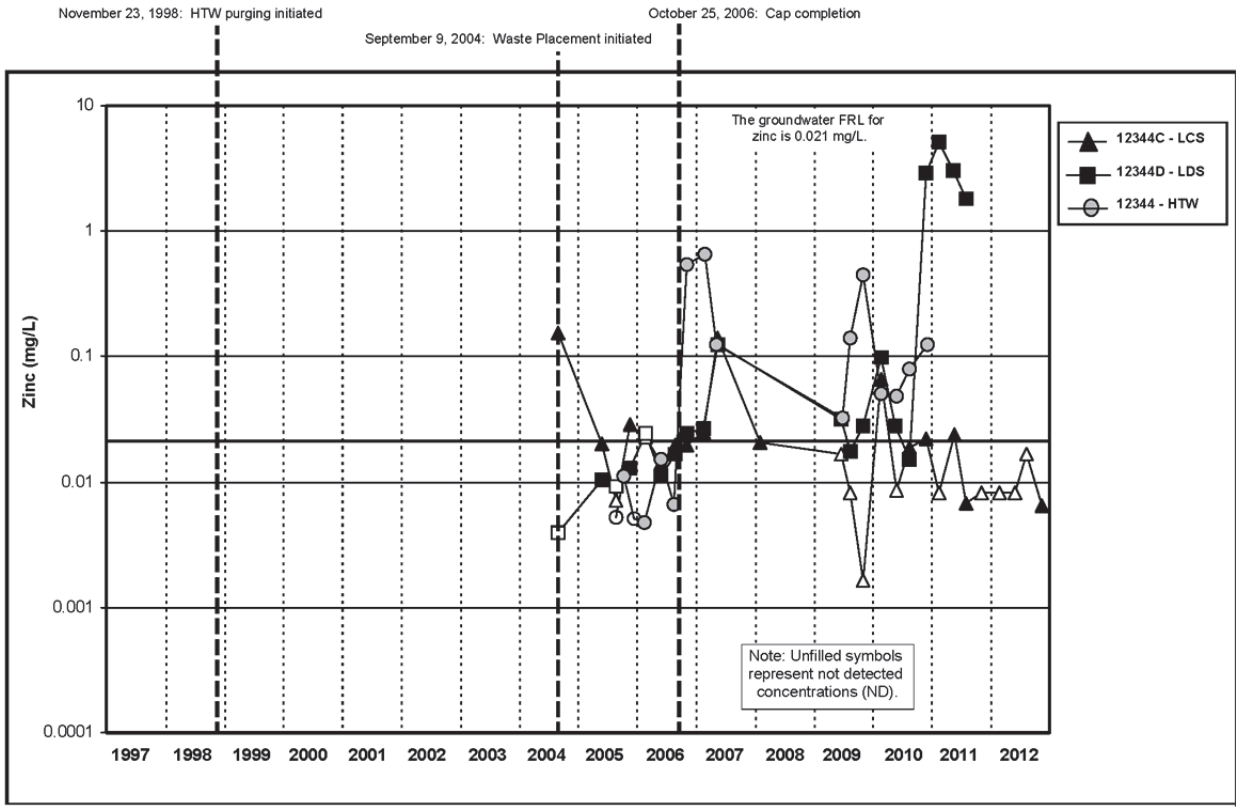

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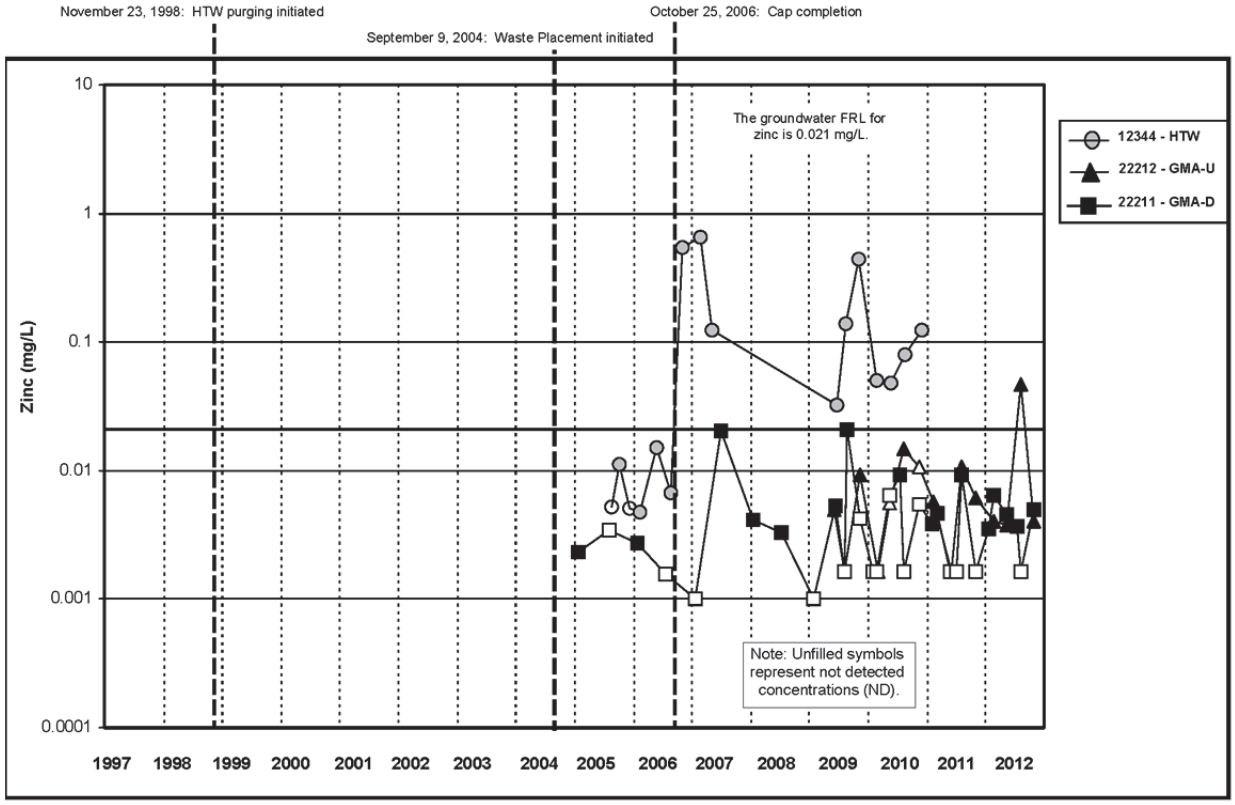
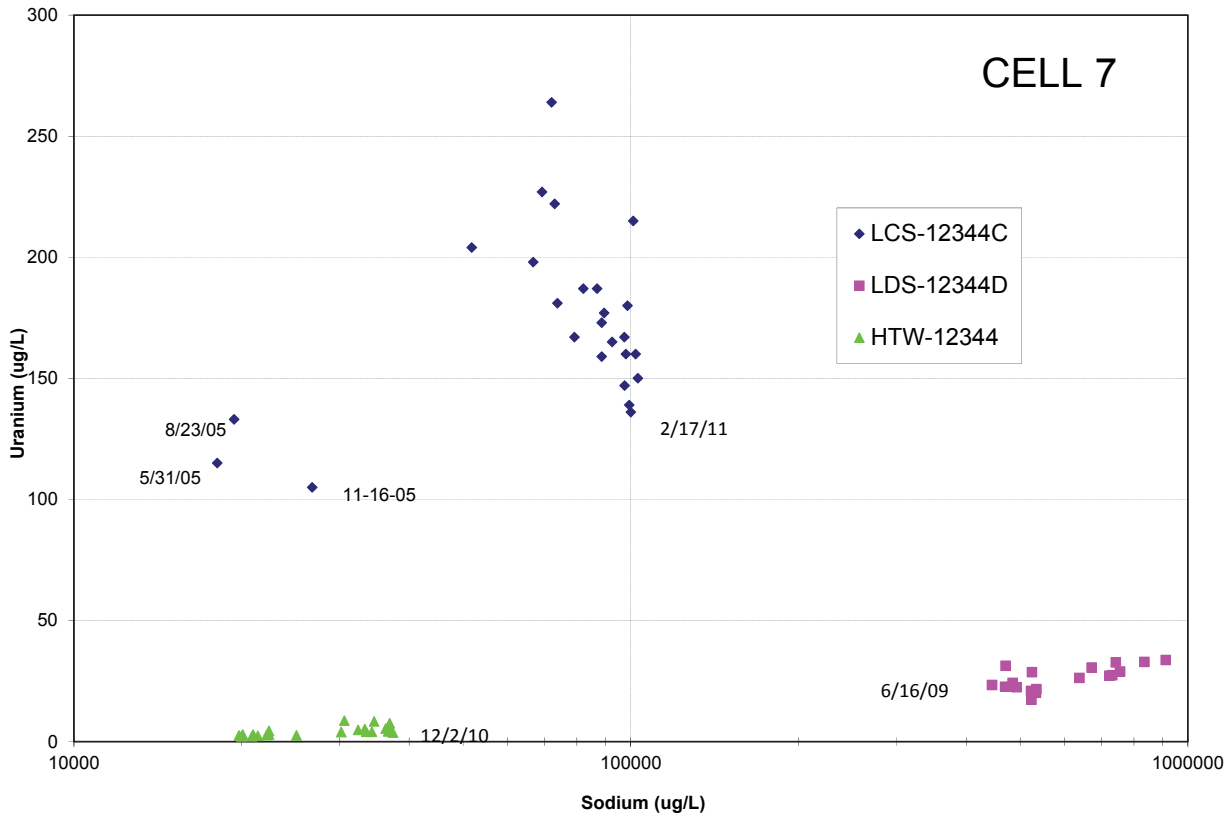


Figure A.5.7–28B. Cell 7 Zinc Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well



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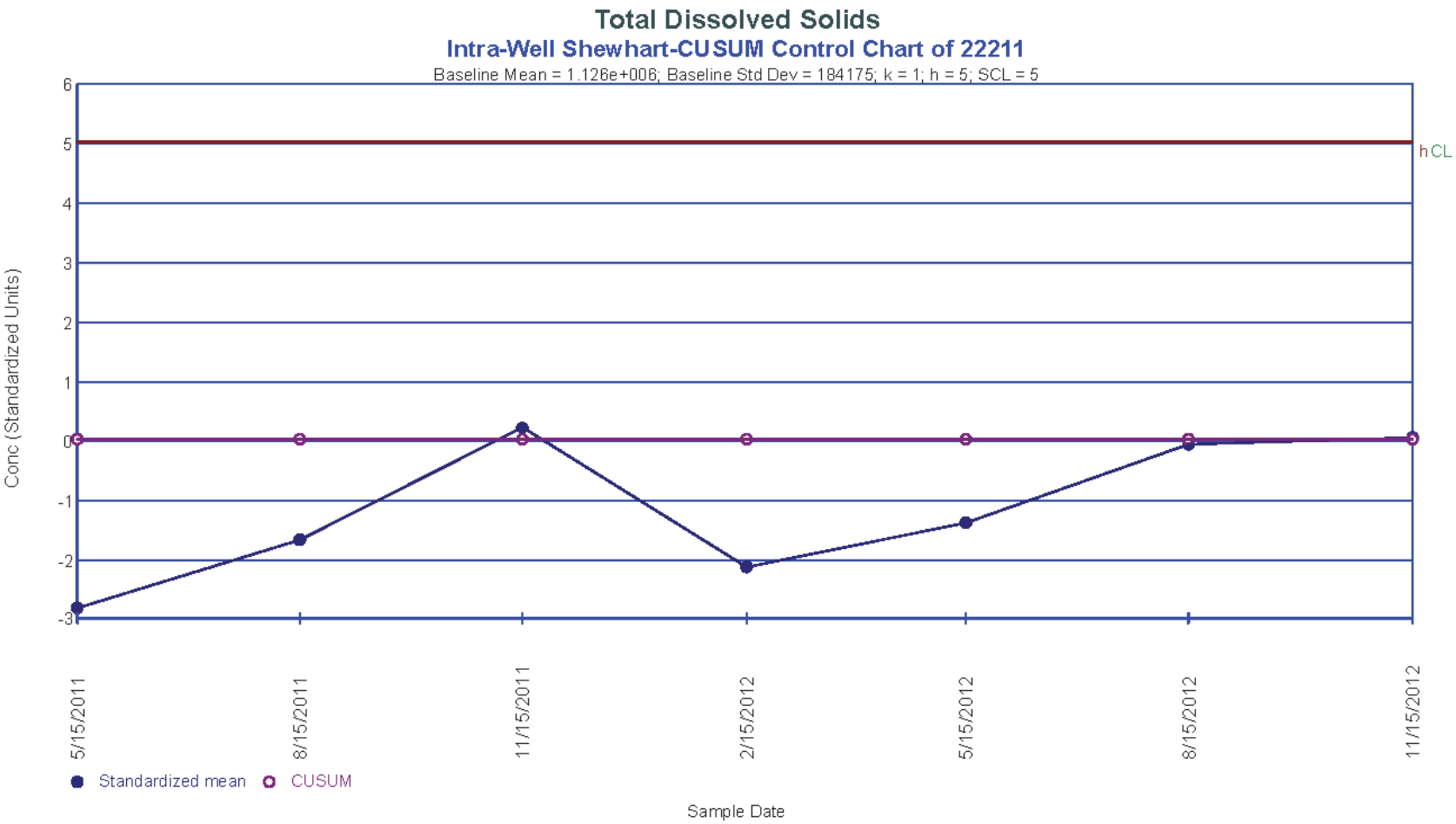
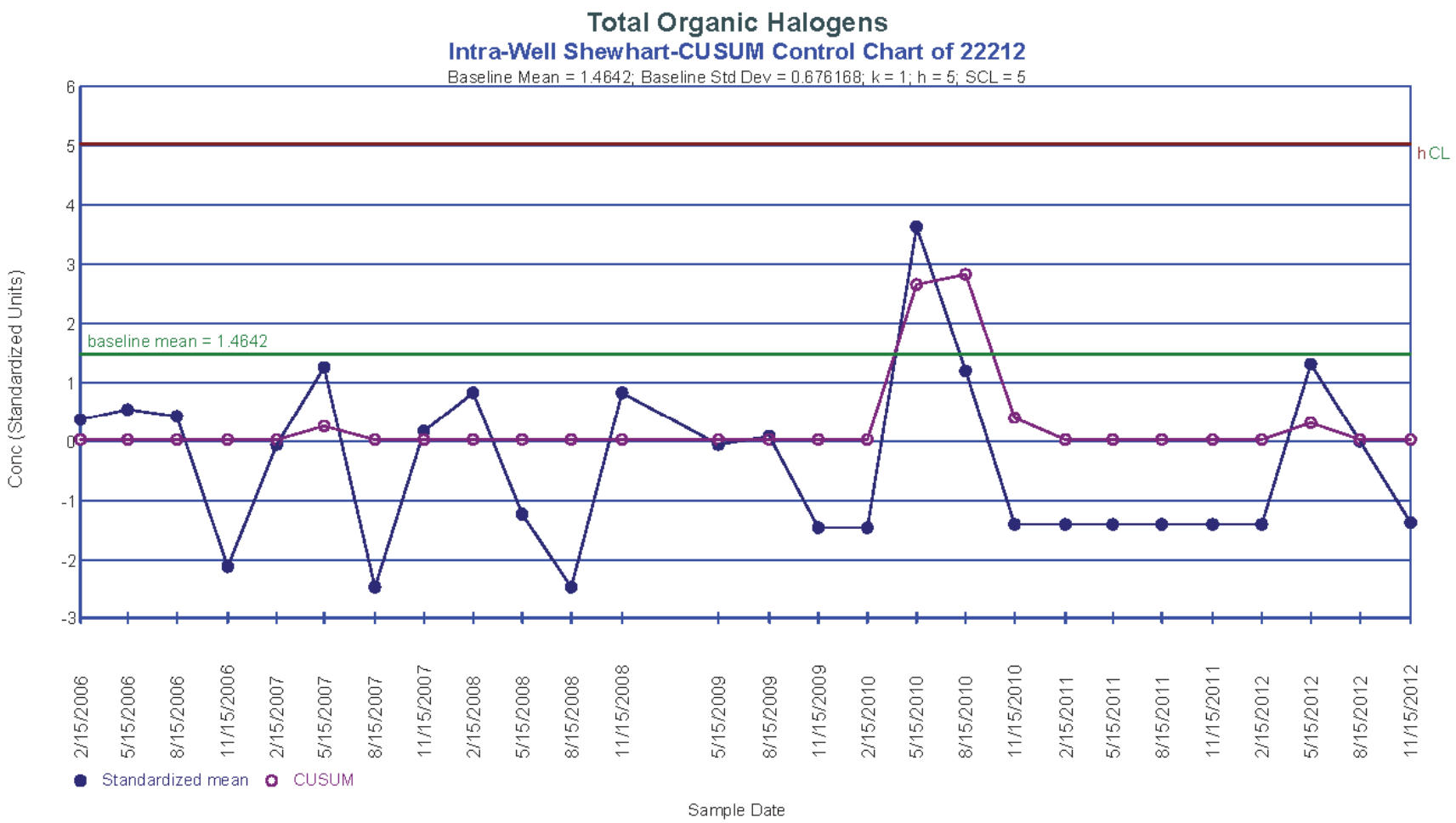


Figure A.5.7–30. Intra-Well Shewhart-CUSUM Control Chart (Total Dissolved Solids 22211)



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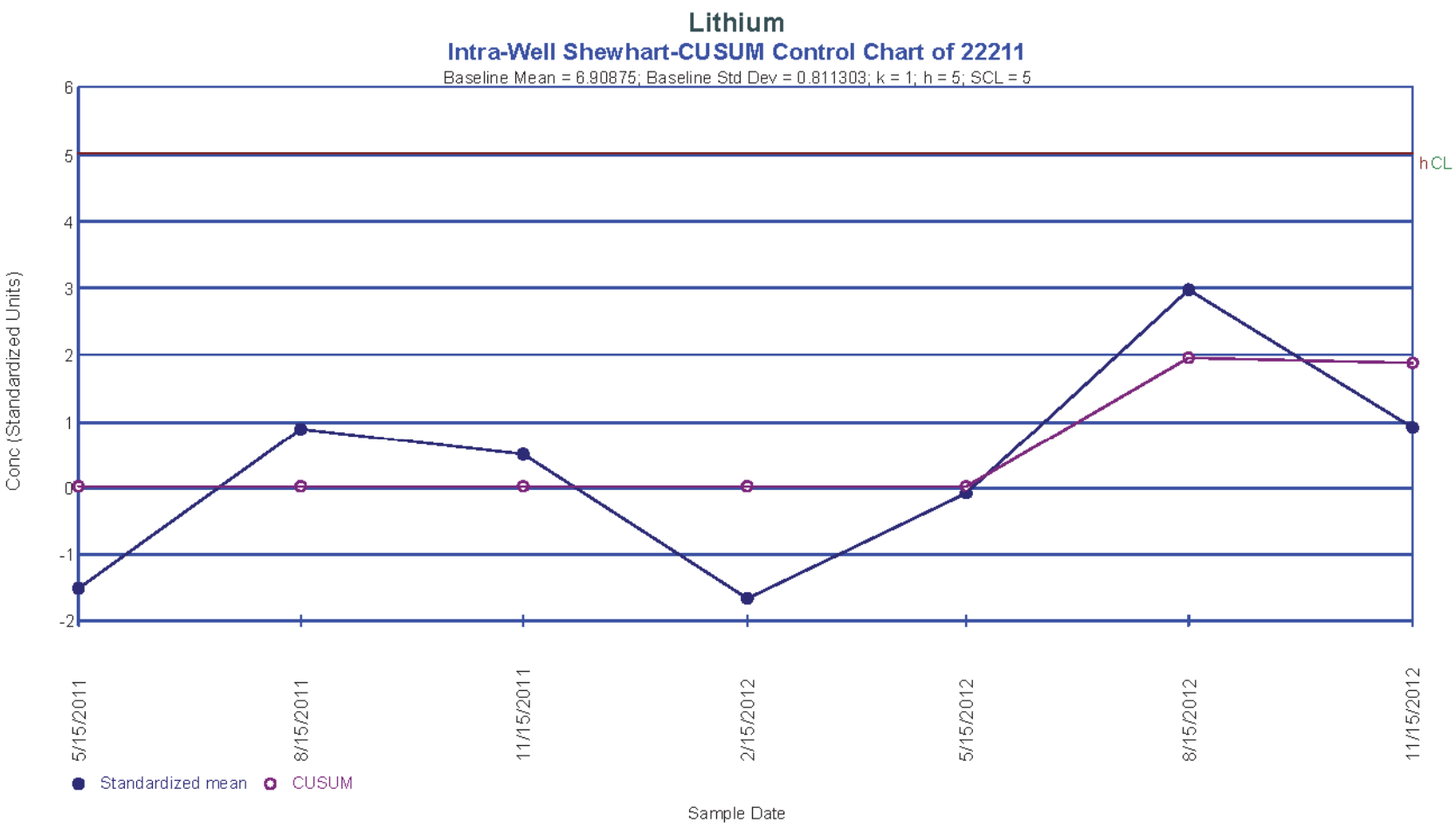

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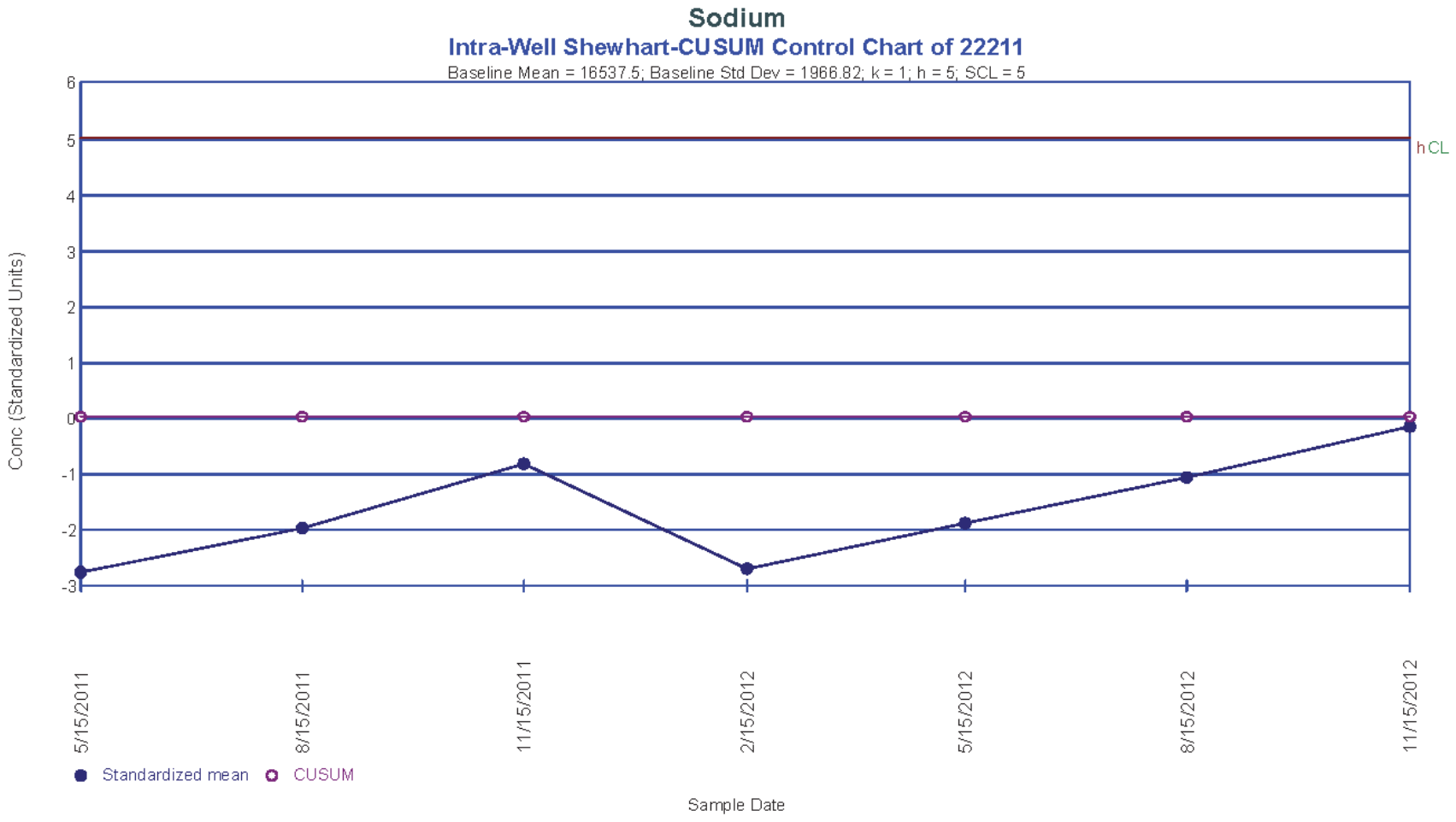

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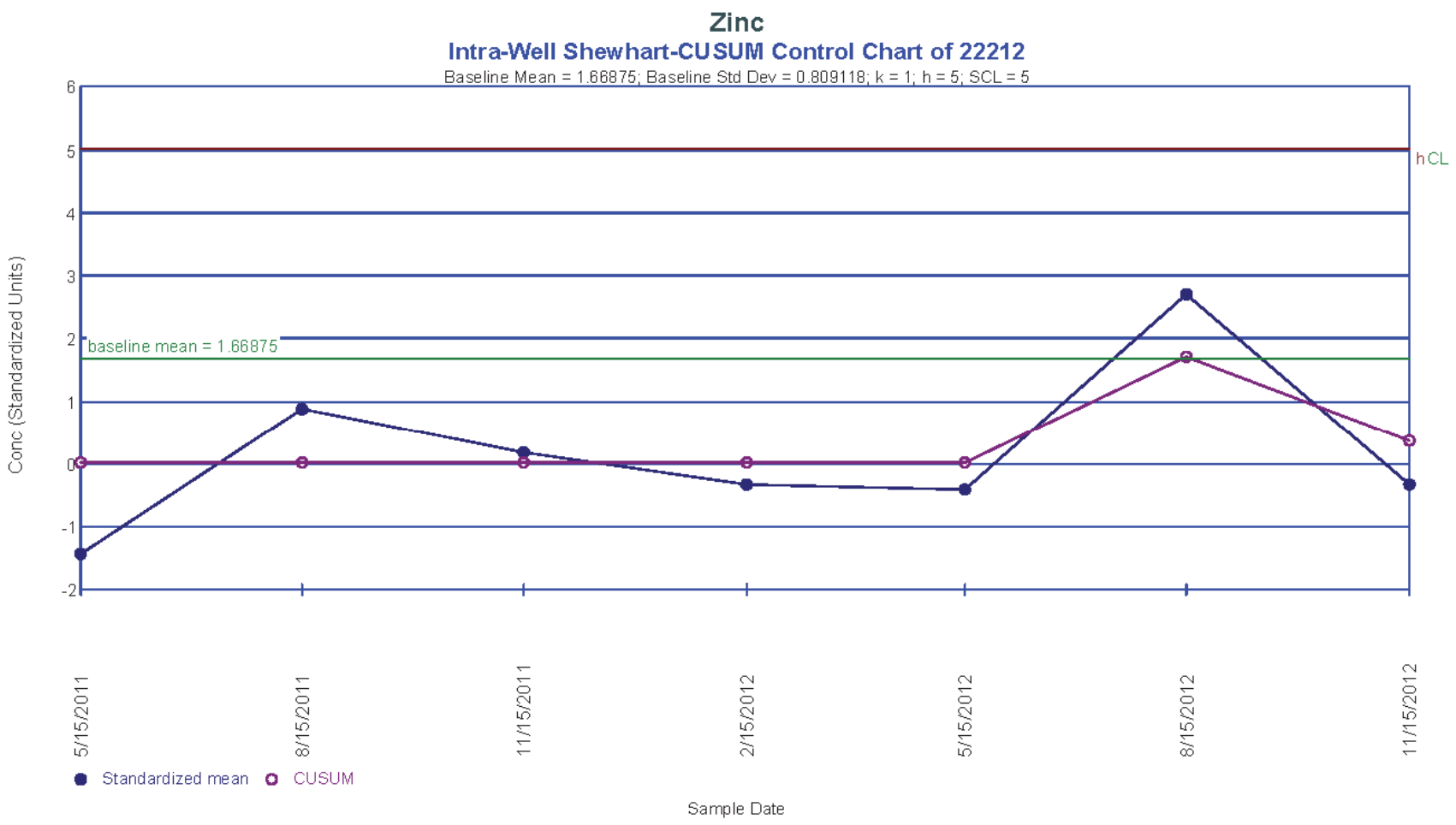

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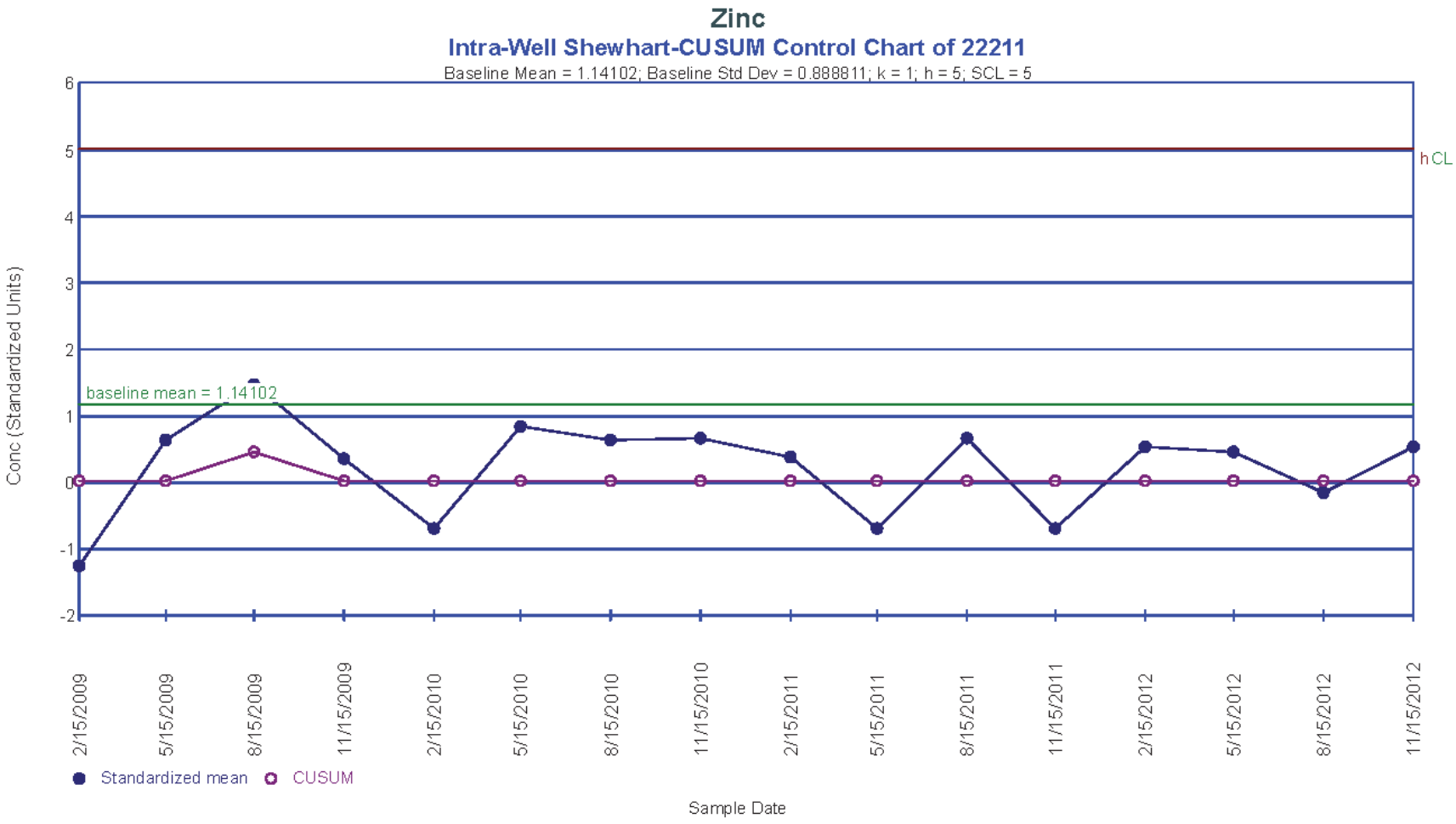

Figure A.5.7–35. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22211)

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Cell 8

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The following information is provided in this sub-attachment:

- Quarterly monitoring summary statistics (refer to Table A.5.8–1)
- Annual LCS sample summary information for detected parameters (refer to Table A.5.8–2)
- LCS monthly accumulation volumes (refer to Figure A.5.8–1)
- LDS monthly accumulation volumes (refer to Figure A.5.8–2)
- OSDF horizontal till well 12345 water yield (refer to Figure A.5.8–3)
- GMA water levels and uranium concentration versus time (refer to Figures A.5.8–4 and A.5.8–7)
- Plots of concentration versus time (refer to Figures A.5.8–8A to A.5.8–30B)
- A bivariate plots (refer to Figure A.5.8–31 and A.5.8–32)
- Control charts (refer to Figures A.5.8–33 to A.5.8–50)

A.5.8.1 Quarterly Monitoring Results

Quarterly water quality monitoring takes place in the LCS, LDS, HTW, and GMA wells of each cell for the purpose of determining if the OSDF is operating as designed. Water quality within the cell is sampled in the LCS and LDS. Water quality beneath the cell is sampled in the HTW and GMA wells. Concentrations versus time plots, bivariate plots, and control charts are used to help interpret and present the results.

In 2012, 23 parameters were sampled in the LCS, LDS, and GMA wells of each cell. HTWs in all cells were sampled for arsenic, uranium, sodium, and sulfate. The Cell 8 LDS and HTW were both dry for all of 2012. In Cell 8, the LCS, LDS, and GMA wells are also sampled quarterly for technetium-99. Quarterly monitoring summary statistics are provided in Table A.5.8–1.

As shown in Table A.5.8–1, and summarized below, 12 of the 23 parameters monitored quarterly in the LCS, LDS, HTW, and GMA wells, (uranium, chloride, sulfate, TDS, TOC, arsenic, boron, lithium, manganese, selenium, sodium, and zinc) have upward concentration trends in the HTW and/or GMA wells based on the Mann-Kendall test for trend. Cell 8 is unique in that it has four GMA wells (GMA-U, GMA-D, GMA-SW, and GMA-SE).

Parameters with upward concentration trends in the HTW and GMA Wells of Cell 8

Parameter	HTW[a] 12345	GMA-U[a] 22213	GMA-D[a] 22214	GMA-SW[a] 22215	GMA-SE[a] 22217
Uranium	Up	Up		Up	
Chloride			Up		
Sulfate	Up	Up		Up	
TDS			Up	Up	
TOC		Up		Up	
Arsenic			Up		
Boron		Up		Up	
Lithium			Up		
Manganese				Up	
Selenium			Up	Up	
Sodium				Up	
Zinc			Up		

[a] HTW = horizontal till well, GMA-U = upgradient Great Miami Aquifer, GMA-D = downgradient Great Miami Aquifer; GMA-SW = southwest Great Miami Aquifer; GMA-SE = southeast Great Miami Aquifer; TDS = total dissolved solids; TOC = total organic carbon.
No entry indicates that the trend was not up.

As indicated above, uranium and sulfate have upward concentration trends in the HTW of Cell 8. If should be noted though, that the HTW of Cell 8 has been dry since the third quarter of 2008, so the upwards trends noted above and in Table A.5.8–1 for the HTW are based on data sets that have not been updated since the third quarter of 2008.

Two bivariate plots are used to illustrate that the LCS, LDS, and HTW of Cell 8 have separate and distinct chemical signatures. A (uranium-sodium) bivariate plot for the Cell 8 LCS, LDS, and HTW is provided in Figure A.5.8–31 and a (uranium-sulfate) bivariate plot for the Cell 8 LCS, LDS, and HTW is provided in Figure A.5.8–32. Both plots show that the chemical signature for uranium-sodium and uranium-sulfate in the LCS are separate and distinct from the signatures seen in the LDS and HTW. The uranium-sulfate plot does a better job than the uranium-sodium plot for showing that the chemical signatures in the LDS and HTW are also separate and distinct. Separate and distinct chemical signatures in the LCS, LDS, and HTW indicate that water is not mixing between the horizons. Therefore, the increasing concentrations measured beneath Cell 8 (i.e., HTW and or GMA wells) are attributed to fluctuating ambient concentrations beneath the cell, and are not related to cell performance.

A.5.8.2 Control Charts

Intrawell control charts employ historical measurements from a compliance point as background The *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (EPA 2009), defines the process of creating a Shewart-CUSUM control chart. Appropriate background data are used to define a baseline for the well. The baseline parameters for the chart, estimates of the mean, and standard deviation are obtained from the background data. These baseline measurements characterize the expected background concentrations at the monitoring point. As future concentrations are collected, the baseline parameters are used to standardize the newly gathered data. After these measurements are standardized and plotted, a control chart is declared “out of control” if future concentrations exceed the baseline control limit. This is indicated on the control chart when either the Shewart or CUSUM plot traces begin

to exceed a control limit. The limit is based on the rationale that if the monitoring point remains unchanged from the baseline condition, new standardized observations should not deviate substantially from the baseline mean. If a change occurs, the standardized values will deviate significantly from the baseline and tend to exceed the control limit.

A minimum of eight samples are recommended for use in ChemStat software to define the baseline for a control chart. Therefore, only sample sets with greater than eight samples were selected for control charts. By default, the ChemStat software plots both a CUSUM control limit (h) and a SCL on the control chart. The software recommends a value of 5 for the CUSUM control limit (h) and a value of 4.5 for the SCL.

EPA Unified Guidance suggests that to simplify the interpretation of the control chart that an out of control condition be based on the CUSUM (h) limit alone. Plotting the SCL limit is not needed. The ChemStat software though, by default, plots both the SCL and CUSUM (h) control limit on the charts. As a "work-a-round", the SCL limit was defined as 5 to match the recommended CUSUM limit. On the charts the combined limit is identified as hCL. For interpretation purposes, regard hCL as the CUSUM limit (h).

As shown in Table A.5.8–1 in gray shading, eleven parameters in the HTW and/or GMA wells of Cell 8 (uranium, sulfate, TDS, TOC, boron, cobalt, iron, manganese, sodium, zinc and technetium-99) meet the criteria for control charts (i.e., more than eight samples, normal or lognormal distribution, no trend, and no serial correlation), resulting in 18 control charts.

Parameter and Monitoring Point[a]	Assessment	Figure Number
Uranium in the GMA-D	In Control	A.5.8–33
Uranium in the GMA-SE	In Control	A.5.8–34
Sulfate in the GMA-D	In Control	A.5.8–35
Sulfate in the GMA-SE	In Control	A.5.8–36
TDS in the GMA-SE	In Control	A.5.8–37
TOC in the GMA-SE	In Control	A.5.8–38
Boron in the GMA-SE	In Control	A.5.8–39
Cobalt in the GMA-SE	In Control	A.5.8–40
Iron in the GMA-U	In Control	A.5.8–41
Iron in the GMA-D	In Control	A.5.8–42
Manganese in the GMA-U	In Control	A.5.8–43
Manganese in the GMA-SE	In Control	A.5.8–44
Sodium in the GMA-U	In control	A.5.8–45
Sodium in the GMA-D	In Control	A.5.8–46
Sodium in the GMA-SE	In Control	A.5.8–47
Zinc in the GMA-U	In Control	A.5.8–48
Zinc in the GMA-SE	In Control	A.5.8–49
Technetium-99 in GMA-U	In Control	A.5.8–50

[a] GMA-D = downgradient Great Miami Aquifer; GMA-U = upgradient Great Miami Aquifer; GMA-SW = southwest Great Miami Aquifer; GMA-SE = southeast Great Miami Aquifer; TDS=total dissolved solids; TOC=total organic carbon

The control charts are presented in Figures A.5.8–33 to A.5.8–50. All of the control charts exhibit "in control" conditions.

A.5.8.3 Annual LCS Sample Results

Annual LCS sampling results for Cell 8 are provided in Table A.5.8–2 for those parameters that were detected at least once, and are not being sampled quarterly. No new Appendix I or PCB parameters were detected in the LCS of Cell 8 in 2012.

A.5.8.4 Cell 8 LDS Sampling

In addition to the 23 parameters being sampled for quarterly in the LCS, LDS, and GMA wells, the Cell 8 LDS is also being sampled for cadmium and 1,1-dichloroethene based on previous sampling results in the Cell 8 LCS.

Cadmium:
Cadmium was detected for the first time in the LCS of Cell 8 in 2011. It was detected again in the LCS of Cell 8 in 2012. Therefore, beginning in the next scheduled sampling event, cadmium will also be sampled in the LDS of Cell 8.

1,1-Dichloroethene:
1,1-dichloroethene was detected for the first time in the LCS of Cell 8 in 2009. In 2010, 1,1-dichloroethene was detected again in the LCS of Cell 8, triggering sampling in the LDS beginning in 2011. Sampled for twice in 2011, 1,1-dichloroethene was not detected in the Cell-8 LDS. Sampled for once in 2012 (during the first three quarters of 2012 the LDS of Cell 8 was dry) 1,1-dichloroethene was not detected in the LDS of Cell 8.

A.5.8.5 Summary and Conclusions

- The LDS of Cell 8 was dry the first three quarters of 2012.
- The HTW of Cell 8 was dry in 2012. It has been dry since the third quarter of 2008.
- Twelve parameters monitored quarterly are increasing in either the HTW and/or GMA wells of Cell 8 (uranium, chloride, sulfate, TDS, TOC, arsenic, boron, lithium, manganese, selenium, sodium, and zinc).
- The chemical signature for uranium-sodium and uranium-sulfate in the LCS of Cell 8 is separate and distinct from the signatures seen in the LDS and HTW. The signature for uranium-sodium the HTW is also separate and distinct from the LDS, but low uranium concentrations in both horizons have the clusters closer than what is seen in the other seven cells. The signature for uranium-sulfate in the HTW is separate and distinct from the LDS. Separate and distinct chemical signatures in the LCS, LDS, and HTW indicate that water is not mixing between the horizons. Concentration increases in the HTW and GMA wells of Cell 8 are attributed to fluctuating ambient concentrations beneath the cell, and not to cell performance. It should also be noted that the HTW of Cell 8 has been dry since the third quarter of 2008, providing additional evidence that the secondary liner is not leaking.
- Eighteen control charts were constructed for Cell 8 parameters. All of the control charts exhibit “in control” conditions.
- No new Appendix I parameters were detected in the LCS of Cell 8 in 2012.

- Cadmium was detected for the second time in the LCS of Cell 8 in 2012. It was detected the first time in 2011. Therefore, beginning in the subsequent next scheduled sampling event, cadmium will also be sampled in the LDS of Cell 8.
- Sampling for 1,1-dichloroethene continues in the LDS of Cell 8, due to two prior detects in the LCS. Sampled for once in 2012, 1,1-dichloroethene was not detected in the LDS of Cell 8.

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Table A.5.8–1. Summary Statistics for Cell 8

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Total Uranium (µg/L)	LCS	12345C	32	32	100	1.51	335	180	68	Normal	Up	Detected	
	LDS	12345D	27	27	100	9.38	64.4	22.0	10.9	LogNormal	Up	Detected	
	HTW	12345	16	16	100	3.67	7.3	5.02	0.99	Normal	Up	Not Detected	
	GMA-U	22213	29	35	82.9	ND	0.627	0.379	0.128	Normal	Up	Detected	
	GMA-D	22214	35	36	97.2	ND	2.37	0.765	0.543	LogNormal	None	Not Detected	
	GMA-SW	22215	26	29	89.7	ND	16.4	0.486	3.17	Undefined	Up	Not Detected	
	GMA-SE	22217	25	25	100	0.898	18.3	8.29	4.70	Normal	None	Not Detected	
Alkalinity as CaCO3 (mg/L)	LCS	12345C	21	21	100	64.9	466	368	139	Undefined	Up	Detected	
	LDS	12345D	13	13	100	170	487	422	113	Undefined	None	Not Detected	
	GMA-U	22213	8	8	100	326	368	341	14	Normal	None	Not Detected	
	GMA-D	22214	8	8	100	291	354	325	19	Normal	None	Not Detected	
	GMA-SW	22215	8	8	100	330	368	342	12	Normal	None	Not Detected	
	GMA-SE	22217	8	8	100	312	348	331	12	Normal	Down	Not Detected	
Chloride (mg/L)	LCS	12345C	21	21	100	18.9	352	227	119	Undefined	Up	Detected	
	LDS	12345D	13	13	100	34.5	104	67.0	25.0	Normal	None	Detected	
	GMA-U	22213	8	8	100	27	52	38.0	8.8	Normal	None	None Detected	
	GMA-D	22214	8	8	100	22.8	34.3	28.9	4.0	Normal	Up	Not Detected	
	GMA-SW	22215	8	8	100	30.2	43.6	37.2	4.5	Normal	None	Not Detected	
	GMA-SE	22217	8	8	100	23.1	40.5	30.4	6.0	Normal	None	Not Detected	
Nitrate, Nitrite (mg/L)	LCS	12345C	20	21	95.2	ND	74.6	32.5	20.5	Normal	None	Detected	
	LDS	12345D	7	13	53.8	ND	3.62	3.62	1.31	Undefined	Up	Detected	
	GMA-U	22213	0	8	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22214	0	8	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-SW	22215	0	8	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-SE	22217	1	8	12.5	ND	0.085	Insufficient	Insufficient	Normal	None	Not Detected	
Sulfate (mg/L)	LCS	12345C	32	32	100	146	4020	2440	1000	Undefined	Up	Detected	
	LDS	12345D	27	27	100	1730	5020	3120	930	Normal	Up	Detected	
	HTW	12345	15	15	100	95.5	152	116	18	Normal	Up	Detected	
	GMA-U	22213	35	35	100	90.2	284	199	63	Undefined	Up	Detected	
	GMA-D	22214	35	35	100	151	457	259	72	LogNormal	None	Not Detected	
	GMA-SW	22215	28	29	96.6	ND	911	149	200	Undefined	Up	Detected	
	GMA-SE	22217	25	25	100	163	1320	444	228	LogNormal	None	Not Detected	
Total Dissolved Solids (mg/L)	LCS	12345C	20	20	100	882	5470	5160	1400	Undefined	Up	Detected	
	LDS	12345D	12	12	100	3860	8340	6260	1300	Normal	Up	Detected	
	GMA-U	22213	15	15	100	660	843	754	62	Normal	Down	Not Detected	
	GMA-D	22214	15	15	100	531	872	714	114	Normal	Up	Detected	
	GMA-SW	22215	15	15	100	457	1800	707	390	Undefined	Up	Detected	
	GMA-SE	22217	15	15	100	842	1550	1070	220	LogNormal	None	Not Detected	
Total Organic Carbon (mg/L)	LCS	12345C	29	32	90.6	ND	5.31	2.37	0.83	LogNormal	None	Not Detected	
	LDS	12345D	26	27	96.3	ND	5.45	3.08	1.02	Normal	None	Detected	
	GMA-U	22213	30	35	85.7	ND	2.23	1.32	0.47	Normal	Up	Detected	
	GMA-D	22214	29	35	82.9	ND	2.03	1.35	0.41	Undefined	None	Not Detected	
	GMA-SW	22215	24	29	82.8	ND	2.83	1.36	0.53	Normal	Up	Detected	
	GMA-SE	22217	24	25	96.0	ND	2.33	1.60	0.36	Normal	None	Not Detected	

Table A.5.8−1 (continued). Summary Statistics for Cell 8

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Total Organic Halogens (mg/L)	LCS	12345C	20	32	62.5	ND	0.08	0.0154	0.0211	Undefined	Up	Detected	
	LDS	12345D	18	27	66.7	ND	0.0794	0.0150	0.0153	LogNormal	None	Not Detected	
	GMA-U	22213	6	35	17.1	ND	0.056	0.0017	0.0099	Undefined	None	Not Detected	
	GMA-D	22214	6	35	17.1	ND	0.059	0.0016	0.0101	Undefined	None	Not Detected	
	GMA-SW	22215	7	29	24.1	ND	0.046	0.0017	0.0091	Undefined	None	Not Detected	
	GMA-SE	22217	9	25	36.0	ND	0.073	0.0016	0.0144	Undefined	None	Not Detected	
Arsenic (mg/L)	LCS	12345C	6	24	25.0	ND	0.142	0.0038	0.0414	Undefined	None	Not Detected	
	LDS	12345D	4	18	22.2	ND	0.0912	0.0104	0.0224	LogNormal	None	Not Detected	
	HTW	12345	0	7	0	ND	NA	Insufficient	Insufficient	Unsufficient	Insufficient	Insufficient	
	GMA-U	22213	6	15	40.0	ND	0.0406	0.0025	0.0112	Undefined	None	Not Detected	
	GMA-D	22214	5	24	20.8	ND	0.0457	0.0025	0.0122	Undefined	Up	Detected	
	GMA-SW	22215	6	15	40.0	ND	0.0430	0.0025	0.0128	Undefined	None	Not Detected	
	GMA-SE	22217	4	15	26.7	ND	0.0344	0.0025	0.0092	Undefined	None	Not Detected	
Barium (mg/L)	LCS	12345C	19	19	100	0.0186	0.103	0.0471	0.0252	LogNormal	Down	Not Detected	
	LDS	12345D	11	11	100	0.0146	0.0837	0.0372	0.0210	Normal	Down	Not Detected	
	GMA-U	22213	8	8	100	0.0948	0.132	0.110	0.012	Normal	Down	Not Detected	
	GMA-D	22214	8	8	100	0.0409	0.105	0.0706	0.0216	Normal	None	Not Detected	
	GMA-SW	22215	8	8	100	0.0409	0.122	0.0758	0.0238	Normal	None	Not Detected	
	GMA-SE	22217	8	8	100	0.0211	0.0844	0.0422	0.0242	LogNormal	Down	Not Detected	
Boron (mg/L)	LCS	12345C	32	32	100	0.0681	0.776	0.669	0.208	Undefined	Up	Detected	
	LDS	12345D	27	27	100	0.582	2.40	0.905	0.459	Undefined	None	Detected	
	GMA-U	22213	32	35	91.4	ND	0.0463	0.0354	0.0070	Undefined	Up	Not Detected	
	GMA-D	22214	33	35	94.3	ND	0.0393	0.0294	0.0060	Undefined	None	Not Detected	
	GMA-SW	22215	27	29	93.1	ND	0.0409	0.0337	0.0062	Undefined	Up	Detected	
	GMA-SE	22217	23	25	92.0	ND	0.0360	0.0275	0.0058	Normal	None	Not Detected	
Calcium (mg/L)	LCS	12345C	19	19	100	65.4	874	613	240	Undefined	Up	Detected	
	LDS	12345D	11	11	100	279	678	491	113	Normal	None	Detected	
	GMA-U	22213	8	8	100	151	186	164	12	Normal	None	Not Detected	
	GMA-D	22214	8	8	100	142	230	182	27	Normal	None	Not Detected	
	GMA-SW	22215	8	8	100	162	446	184	121	Undefined	None	Not Detected	
	GMA-SE	22217	8	8	100	199	334	238	47	Normal	None	Not Detected	
Cobalt (mg/L)	LCS	12345C	10	24	41.7	ND	0.0029	0.0006	0.0008	Undefined	Down	Detected	
	LDS	12345D	7	18	38.9	ND	0.0025	0.0006	0.0008	Undefined	Down	Not Detected	
	GMA-U	22213	0	15	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22214	0	15	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-SW	22215	0	15	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-SE	22217	11	15	73.3	ND	0.00216	0.0012	0.0005	Normal	None	Not Detected	
Copper (mg/L)	LCS	12345C	14	24	58.3	ND	0.0309	0.0079	0.0079	Undefined	None	Not Detected	
	LDS	12345D	9	18	50.0	ND	0.0427	0.0083	0.0124	Undefined	Down	Not Detected	
	GMA-U	22213	5	8	62.5	ND	0.0111	0.0040	0.0038	LogNormal	Down	Not Detected	
	GMA-D	22214	5	8	62.5	ND	0.0105	0.0040	0.0038	LogNormal	None	Not Detected	
	GMA-SW	22215	5	8	62.5	ND	0.0102	0.0051	0.0042	LogNormal	Down	Detected	
	GMA-SE	22217	6	8	75.0	ND	0.0127	0.0048	0.0042	Normal	Down	Not Detected	

Table A.5.8−1 (continued). Summary Statistics for Cell 8

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Iron (mg/L)	LCS	12345C	17	24	70.8	ND	3.91	0.0972	1.01	Undefined	Down	Detected	
	LDS	12345D	15	18	83.3	ND	6.20	2.12	1.98	LogNormal	Down	Detected	
	GMA-U	22213	15	15	100	0.551	2.83	1.94	1.10	Normal	None	Not Detected	
	GMA-D	22214	15	15	100	2.25	6.69	3.89	1.10	Normal	None	Not Detected	
	GMA-SW	22215	15	15	100	4.78	17.4	5.48	2.95	Undefined	None	Not Detected	
	GMA-SE	22217	15	15	100	0.428	10.3	3.92	2.95	Normal	Down	Not Detected	
Lithium (mg/L)	LCS	12345C	23	23	100	0.0073	0.274	0.111	0.085	Undefined	Up	Detected	
	LDS	12345D	17	17	100	0.0702	0.369	0.207	0.001	Normal	Up	Detected	
	GMA-U	22213	15	15	100	0.00489	0.00728	0.00560	0.00066	Normal	Down	Not Detected	
	GMA-D	22214	15	15	100	0.00431	0.00718	0.00550	0.00087	Normal	Up	Detected	
	GMA-SW	22215	15	15	100	0.00467	0.00828	0.00533	0.00101	Undefined	None	Detected	
	GMA-SE	22217	15	15	100	0.00488	0.00799	0.00640	0.00097	Normal	Down	Not Detected	
Magnesium (mg/L)	LCS	12345C	19	19	100	21.9	644	427	231	Undefined	Up	Detected	
	LDS	12345D	11	11	100	148	828	402	253	Normal	None	Detected	
	GMA-U	22213	8	8	100	34.6	42.0	37.5	2.2	Normal	Down	Not Detected	
	GMA-D	22214	8	8	100	32.2	48.4	41.4	5.3	Normal	None	Not Detected	
	GMA-SW	22215	8	8	100	34.6	74.5	38.1	15.0	Undefined	None	Not Detected	
	GMA-SE	22217	8	8	100	40	55.2	46.3	4.9	Normal	None	Not Detected	
Manganese (mg/L)	LCS	12345C	11	24	45.8	ND	0.328	0.0305	0.169	LogNormal	None	Not Detected	
	LDS	12345D	12	18	66.7	ND	0.687	0.112	0.169	LogNormal	None	Not Detected	
	GMA-U	22213	15	15	100	0.217	0.281	0.253	0.020	Normal	None	Not Detected	
	GMA-D	22214	24	24	100	0.293	0.764	0.387	0.513	Undefined	None	Not Detected	
	GMA-SW	22215	15	15	100	0.24	1.94	0.308	0.513	Undefined	Up	Detected	
	GMA-SE	22217	15	15	100	0.537	1.57	1.04	0.33	Normal	None	Not Detected	
Nickel (mg/L)	LCS	12345C	20	24	83.3	ND	0.018	0.0061	0.0044	LogNormal	Down	Detected	
	LDS	12345D	16	18	88.9	ND	0.022	0.0115	0.0066	Normal	None	Not Detected	
	GMA-U	22213	1	15	6.7	ND	0.00176	Insufficient	Insufficient	Undefined	None	Detected	
	GMA-D	22214	5	24	20.8	ND	0.0063	0.00075	0.00124	Undefined	None	Detected	
	GMA-SW	22215	2	15	13.3	ND	0.00524	Insufficient	Insufficient	Undefined	None	Detected	
	GMA-SE	22217	10	15	66.7	ND	0.0228	0.0048	0.0058	Undefined	None	Not Detected	
Potassium (mg/L)	LCS	12345C	19	19	100	4.86	27.6	25.2	7.4	Undefined	Up	Detected	
	LDS	12345D	11	11	100	38.0	99.4	69.7	22.9	Normal	None	Not Detected	
	GMA-U	22213	8	8	100	3.67	4.14	3.88	0.16	Normal	None	Not Detected	
	GMA-D	22214	8	8	100	2.47	3.07	2.77	0.22	Normal	None	Not Detected	
	GMA-SW	22215	8	8	100	3.18	5.01	3.50	0.69	Undefined	None	Not Detected	
	GMA-SE	22217	8	8	100	2.95	4.09	3.30	0.38	Normal	None	Not Detected	
Selenium (mg/L)	LCS	12345C	4	24	16.7	ND	0.151	0.0126	0.0332	LogNormal	None	Not Detected	
	LDS	12345D	2	18	11.1	ND	0.075	Insufficient	Insufficient	LogNormal	None	Not Detected	
	GMA-U	22213	0	15	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-D	22214	1	15	6.7	ND	0.0125	Insufficient	Insufficient	Undefined	Up	Detected	
	GMA-SW	22215	2	15	13.3	ND	0.00745	Insufficient	Insufficient	Undefined	Up	Detected	
	GMA-SE	22217	0	15	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	

Table A.5.8−1 (continued). Summary Statistics for Cell 8

Parameter	Horizon[a]	Location	Number of Detected Samples	Total Number of Samples	Percent Detects	Minimum[b]	Maximum[b]	Average[c,d]	Standard[d] Deviation	Distribution[d,e] Type	Trend[d,f]	Serial[d,g] Correlation	Outliers[h,i]
Sodium (mg/L)	LCS	12345C	24	24	100	16.8	119	102	36	Undefined	Up	Detected	
	LDS	12345D	18	18	100	76.6	762	422	196	Normal	Up	Detected	
	HTW	12345	7	7	100	277	385	334	45	Normal	Down	Not Detected	
	GMA-U	22213	15	15	100	20.2	30.3	26.4	3.1	Normal	None	Not Detected	
	GMA-D	22214	15	15	100	9.83	13.6	11.1	1.0	Normal	None	Not Detected	
	GMA-SW	22215	15	15	100	13.5	19.6	16.7	1.9	Normal	Up	Detected	
	GMA-SE	22217	15	15	100	11.5	16.2	13.9	1.5	Normal	None	Not Detected	
Zinc (mg/L)	LCS	12345C	12	24	50.0	ND	0.0622	0.0143	0.0147	LogNormal	Up	Detected	
	LDS	12345D	14	18	77.8	ND	0.333	0.150	0.105	LogNormal	Up	Detected	
	GMA-U	22213	8	15	53.3	ND	0.0221	0.0060	0.0053	LogNormal	None	Not Detected	
	GMA-D	22214	12	24	50	ND	0.00705	0.0034	0.0019	Normal	Up	Not Detected	
	GMA-SW	22215	8	15	53.3	ND	0.0158	0.0049	0.0043	Undefined	None	Not Detected	
	GMA-SE	22217	9	15	60.0	ND	0.0184	0.0073	0.0055	LogNormal	None	Not Detected	
Technetium-99 (mg/L)	LCS	12345C	16	26	61.5	ND	101	29.2	28.3	LogNormal	None	Detected	
	LDS	12345D	2	18	11.1	ND	3.44	Insufficient	Insufficient	LogNormal	None	Not Detected	
	GMA-U	22213	6	26	23.1	ND	24.8	3.14	4.65	LogNormal	None	Not Detected	
	GMA-D	22214	4	26	15.4	ND	11.8	0.0852	3.07	Undefined	None	Detected	
	GMA-SW	22215	0	20	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	
	GMA-SE	22217	0	16	0	ND	NA	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient	

Note 1: Shading identifies a horizontal till well or Great Miami Aquifer well, with more than 8 samples, normal or lognormal distribution, no trend, and no serial correlation. These wells meet control chart criteria.

Note 2: Data used in this table has been standardized to quarterly.

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]ND = not detected; NA = not applicable

[c]Averages were determined based on the distribution assumption.

[d]Insufficient and is used for Distribution Type, Trend, or Serial Correlation whenever there is not enough data to run the test, for average whenever there is less than 4 detections, and for standard deviation whenever there are less than 5 detections.

[e]Data distribution based on the Shapiro-Wilk statistic.

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[f]Trend based on nonparametric Mann-Kendall procedure.

[g]Serial correlation based on Rank Von Neumann test.

[h]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 25).

[i]Q = quarterly

Table A.5.8–2. Cell 8 Annual LCS Sample Summary Information for Detected Parameters

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	DETECTED IN 2011	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)
General Chemistry											
Ammonia (mg/L)	9	3	33.3	Yes	0.03	0.177	0.084	-	4.2 mg/L(0)	4.34 mg/L(0)	220 mg/L(0)
Inorganics											
Cadmium (mg/L)	9	2	22.2	Yes	0.000127	-	-	0.014 mg/L(0)	0.014 mg/L(0)	-	0.05 mg/L(0)
Chromium (mg/L)	9	3	33.3	No	0.0016	0.0269	0.0107	0.022 mg/L[g](1)	0.021 mg/L(1)	0.0046 mg/L(1)	0.818 mg/L(0)
Thallium (mg/L)	9	1	11.1	No	0.00057	-	-	-	-	-	0.0028 mg/L(0)
Vanadium (mg/L)	9	1	11.1	No	0.016	-	-	0.038 mg/L(0)	0.012 mg/L(1)	0.005 mg/L(1)	0.299 mg/L(0)
Organics											
1,1-Dichloroethene	20	3	15.0	No	0.86	2.11	1.65	7 ug/L(0)	-	-	-
Acetone	9	1	11.1	No	2.31	-	-	-	-	-	-
Aroclor - 1260	9	1	11.1	No	0.058	-	-	-	-	-	-
Tetrachloroethene	20	7	35.0	Yes	0.38	1.24	0.732	-	-	-	-
Trichloroethene	20	3	15.0	No	0.246	1.11	0.587	5 ug/L(0)	-	-	-

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on hexavalent chromium from Operable Unit 5 Record of Decision, Table 9-4.

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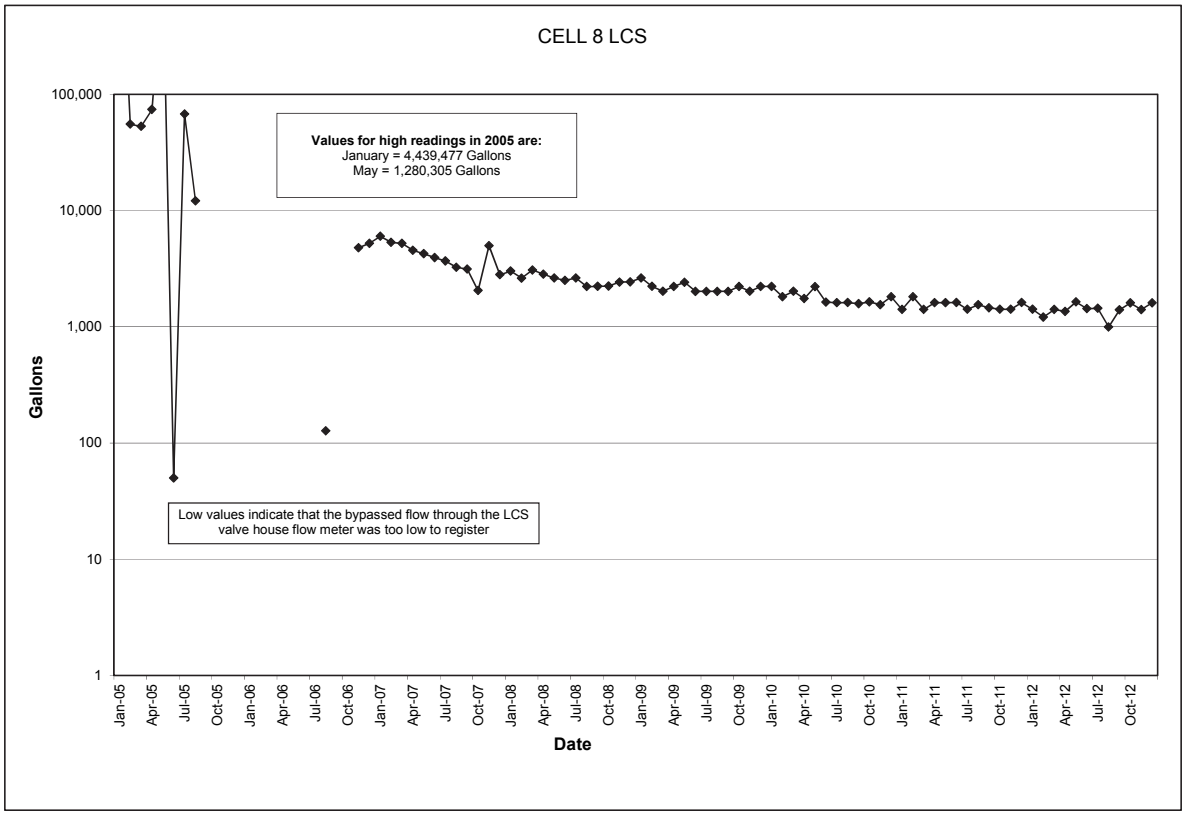


Figure A.5.8–1. Monthly Accumulation Volumes for Cell 8 LCS

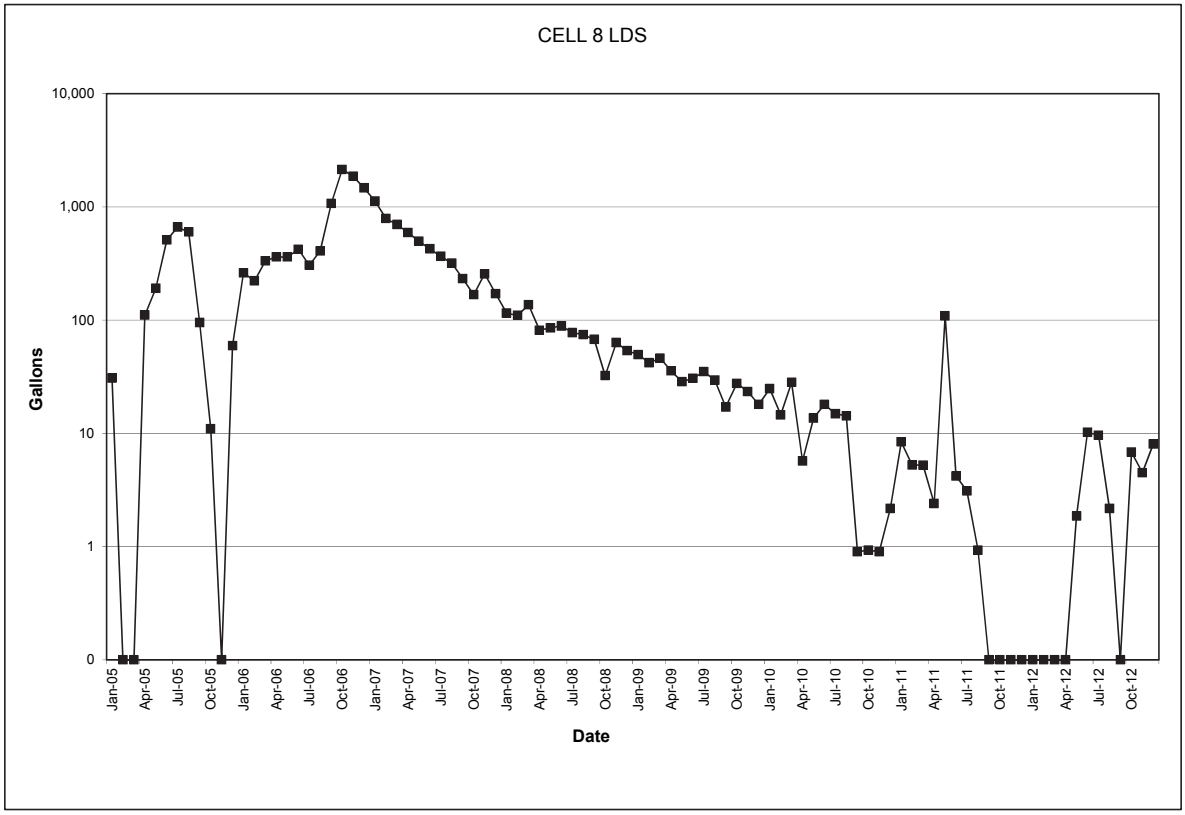
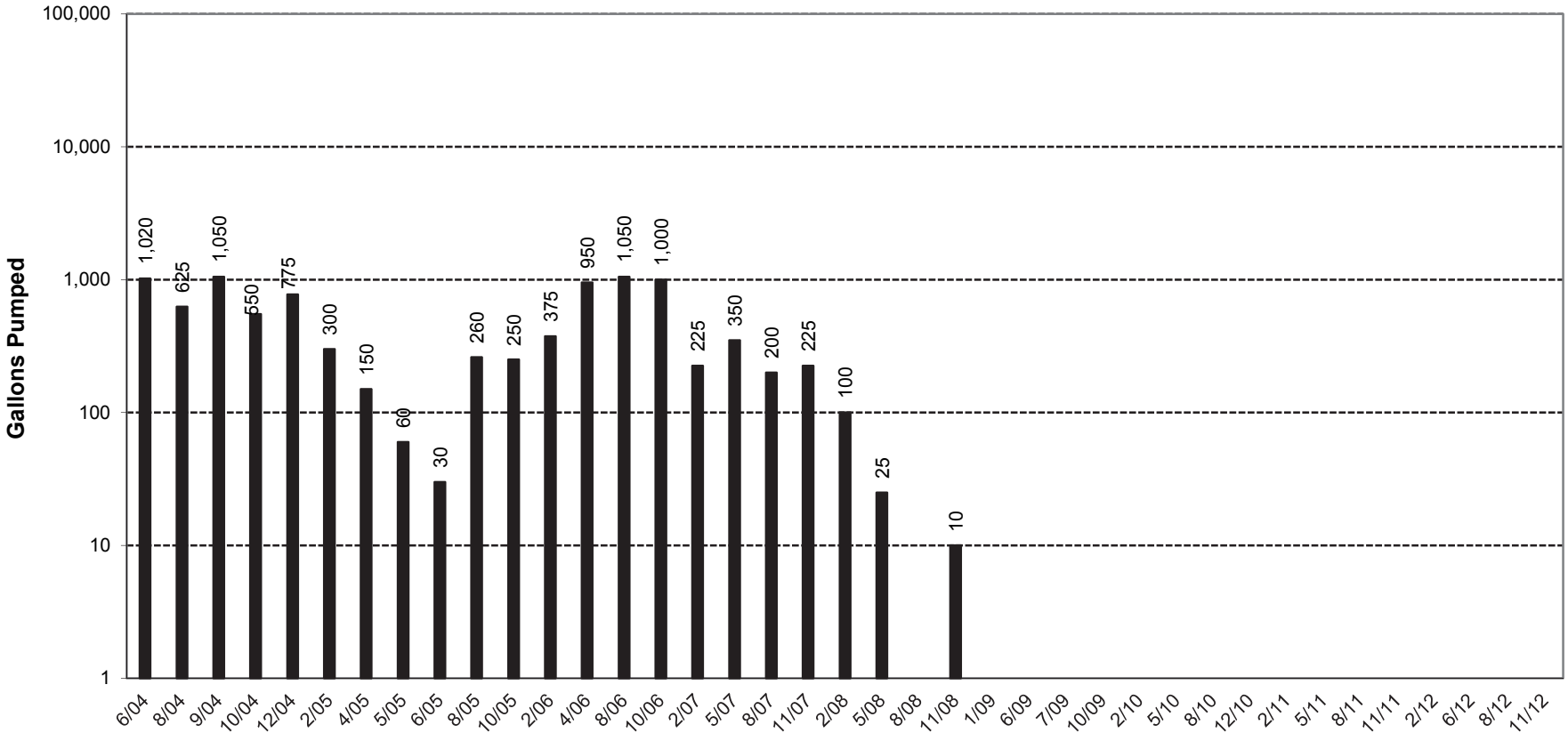


Figure A.5.8–2. Monthly Accumulation Volumes for Cell 8 LDS



12345 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
2004:	4020	n=5	804
2005:	1050	n=6	175
2006:	3375	n=4	844
2007:	1000	n=4	250
2008:	135	n=4	34
2009:	0	n=3	0
2010:	0	n=4	0
2011:	0	n=4	0
2012:	0	n=4	0
Overall:			252

Figure A.5.8–3. OSDF Horizontal Till Well 12343 (Cell 8) Water Yield

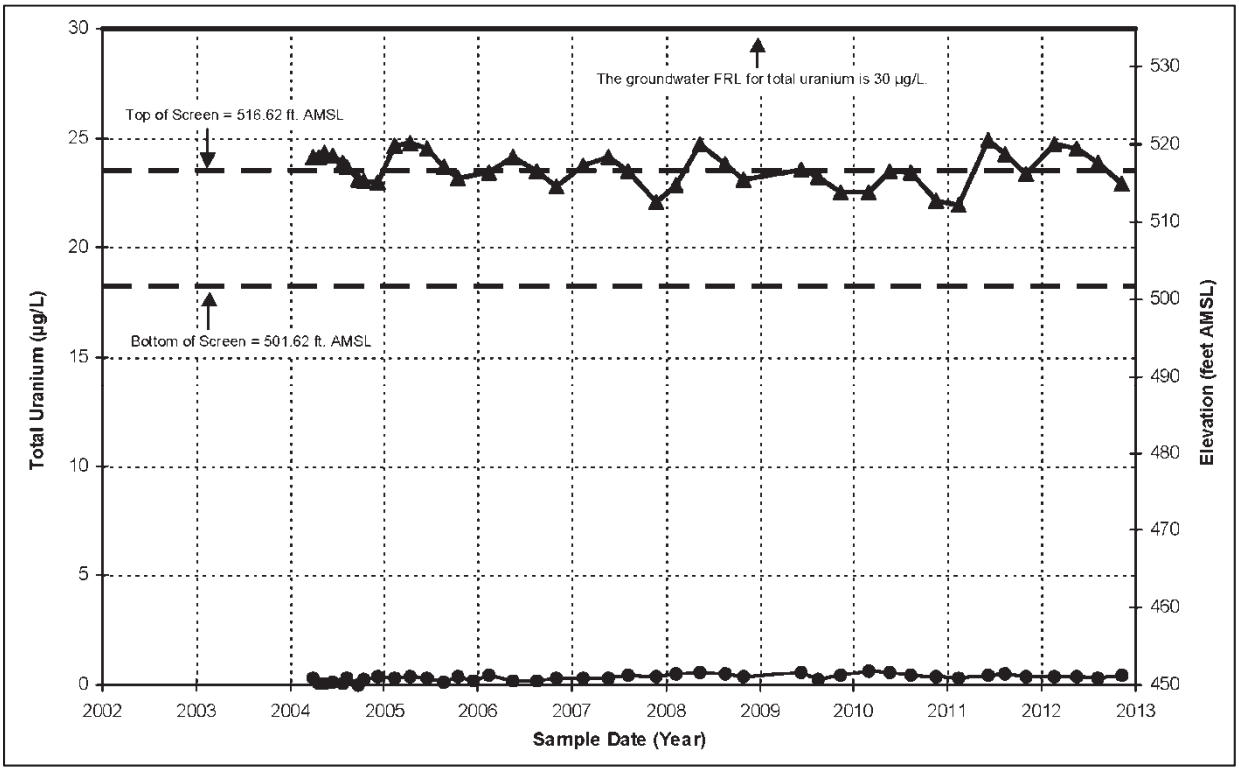


Figure A.5.8–4. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 8 Upgradient Monitoring Well 22213

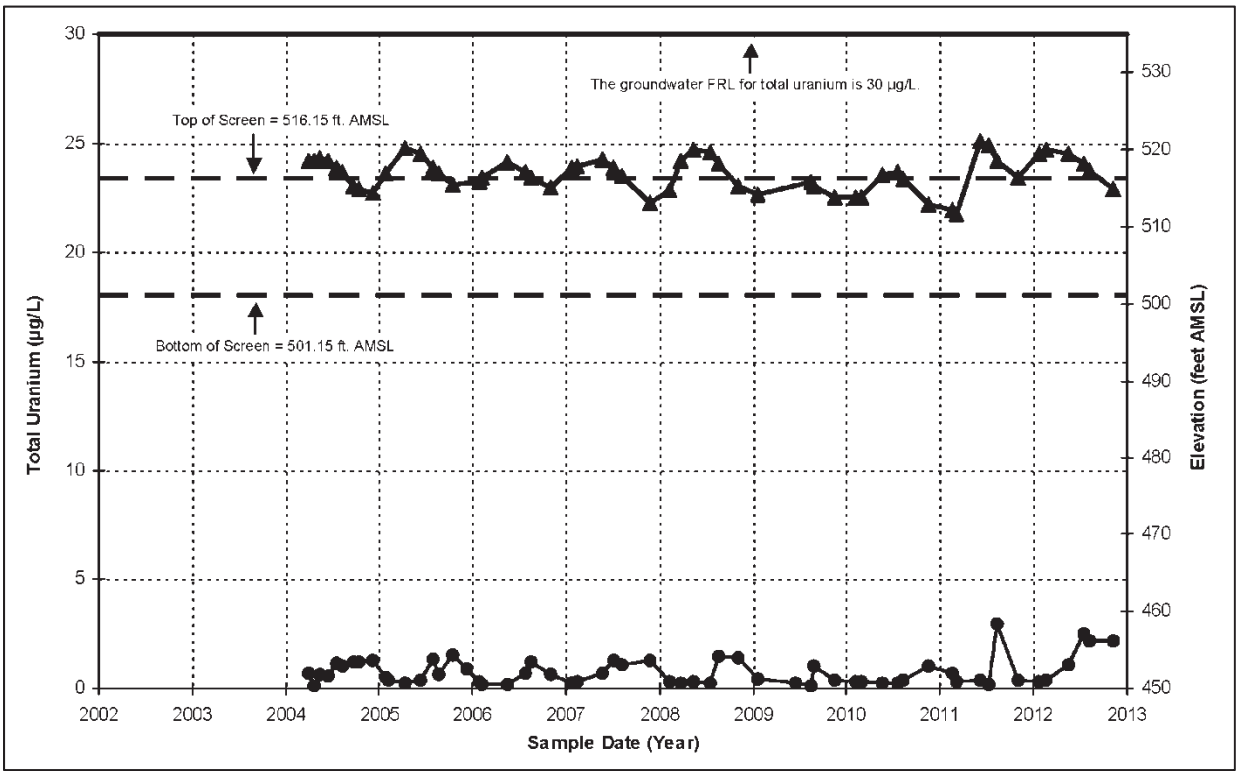


Figure A.5.8–5. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 8 Downgradient Monitoring Well 22214

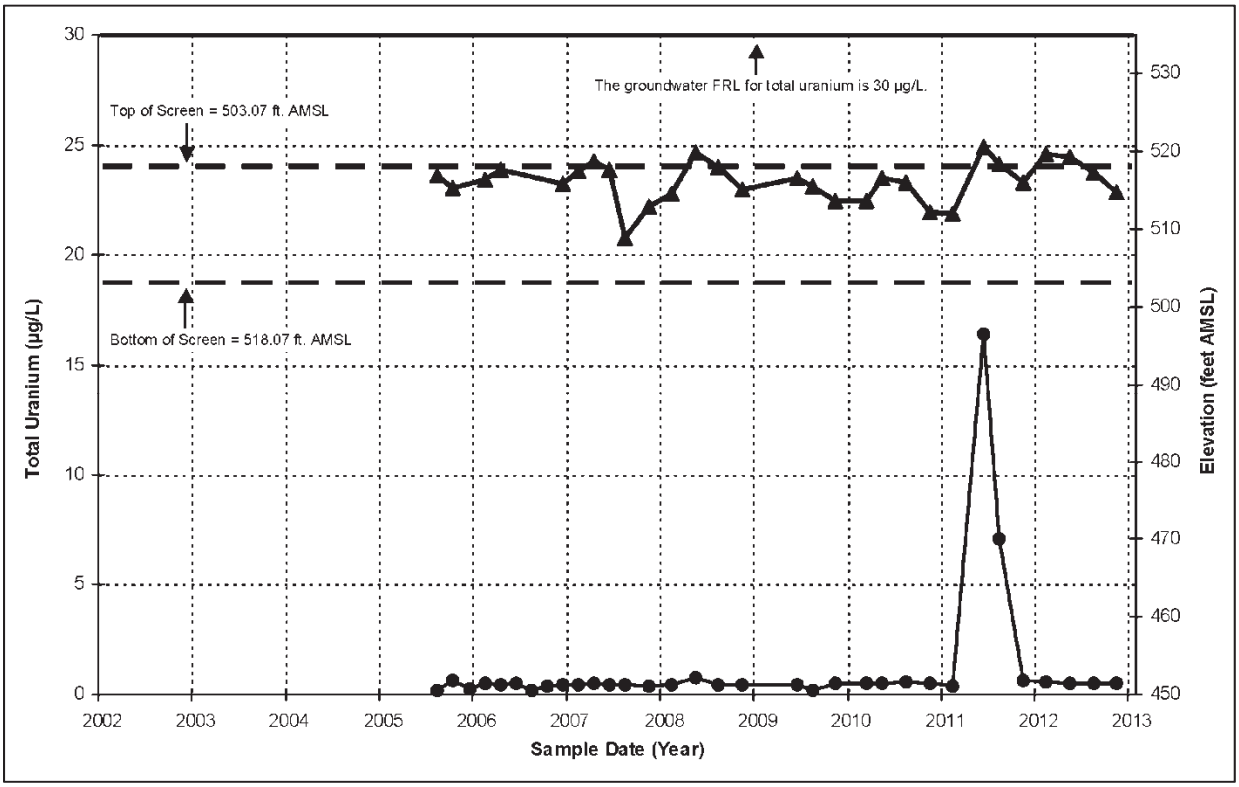


Figure A.5.8–6. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 8 Downgradient Monitoring Well 22215

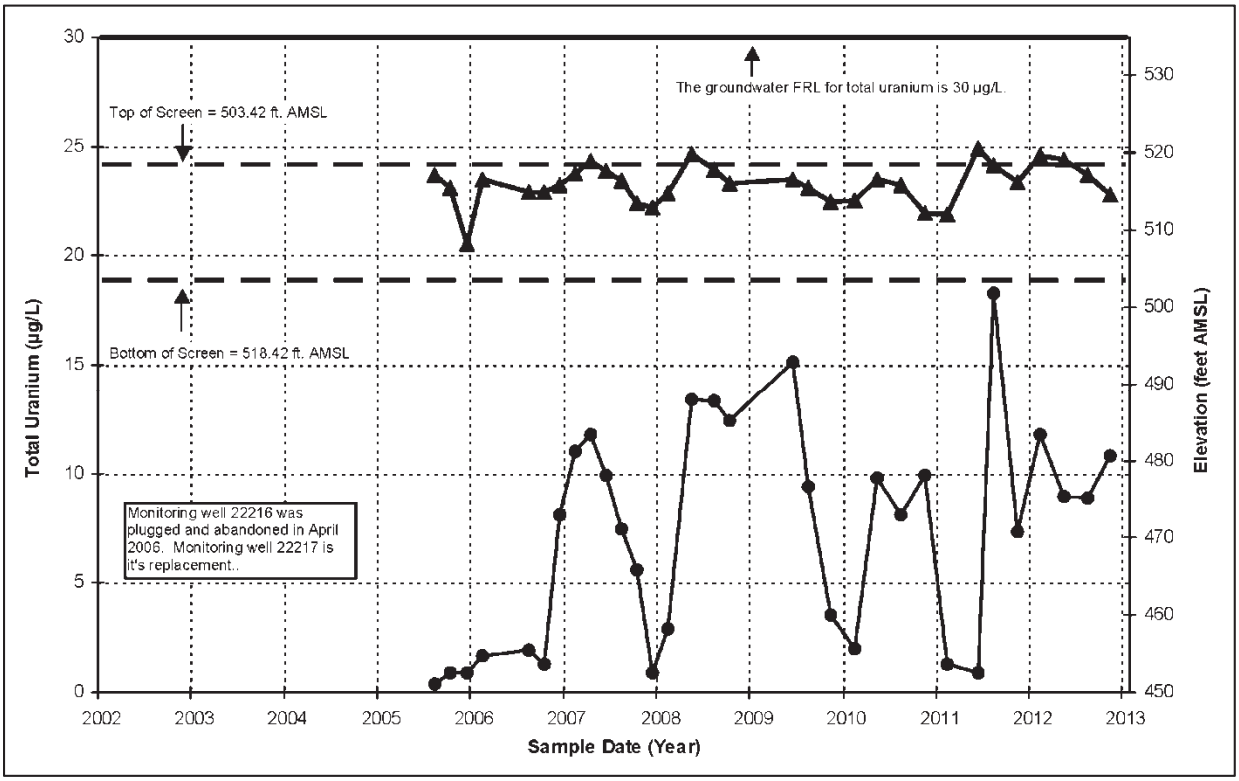


Figure A.5.8–7. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 8 Downgradient Monitoring Well 22216/22217

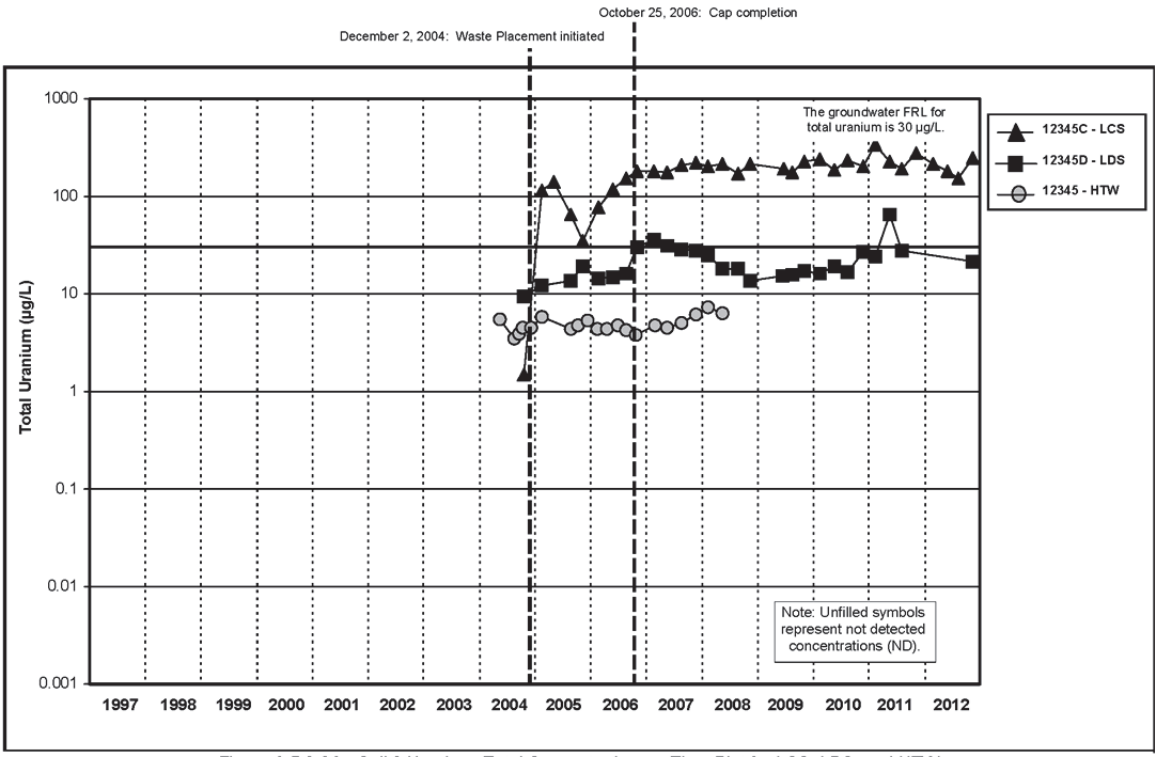


Figure A.5.8–8A. Cell 8 Uranium, Total Concentration vs. Time Plot for LCS, LDS, and HTW

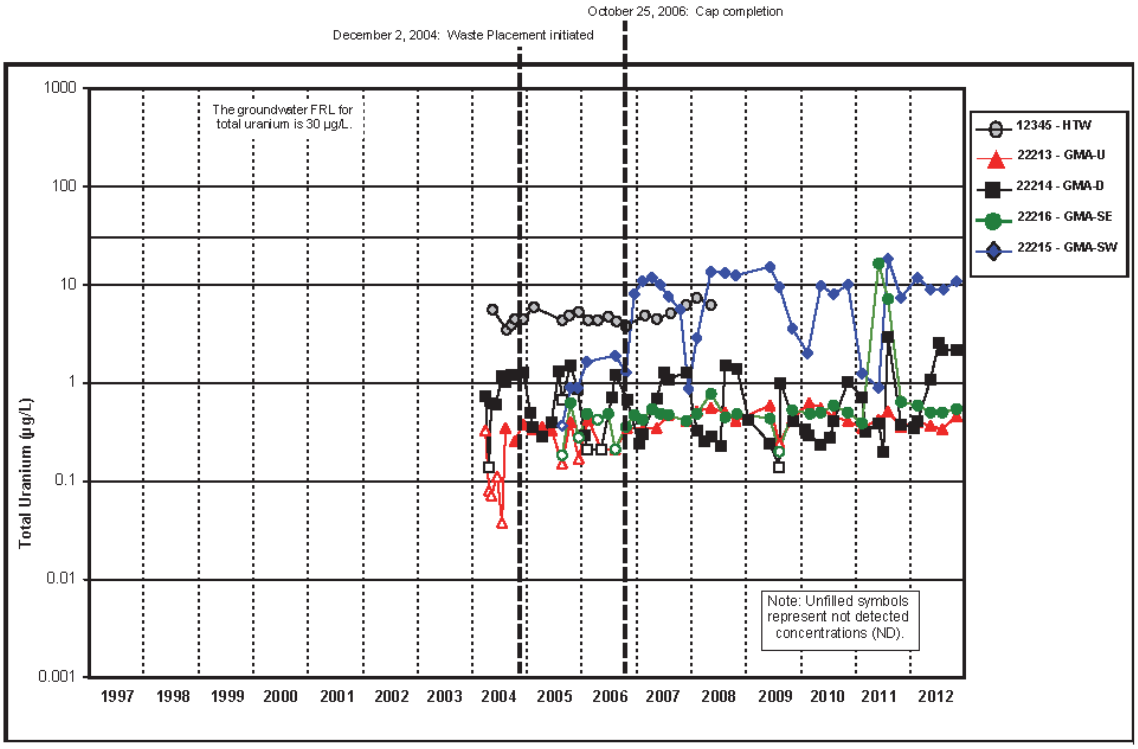


Figure A.5.8–8B. Cell 8 Uranium, Total Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

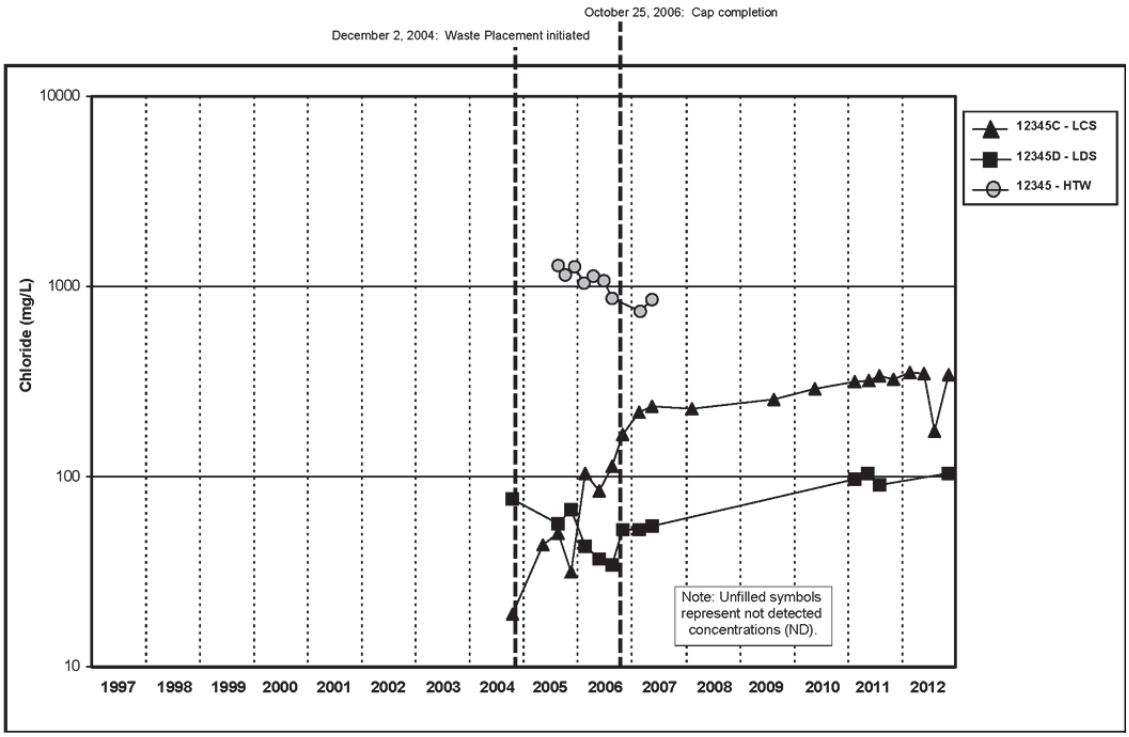


Figure A.5.8–9A. Cell 8 Chloride Concentration vs. Time Plot for LCS, LDS, and HTW

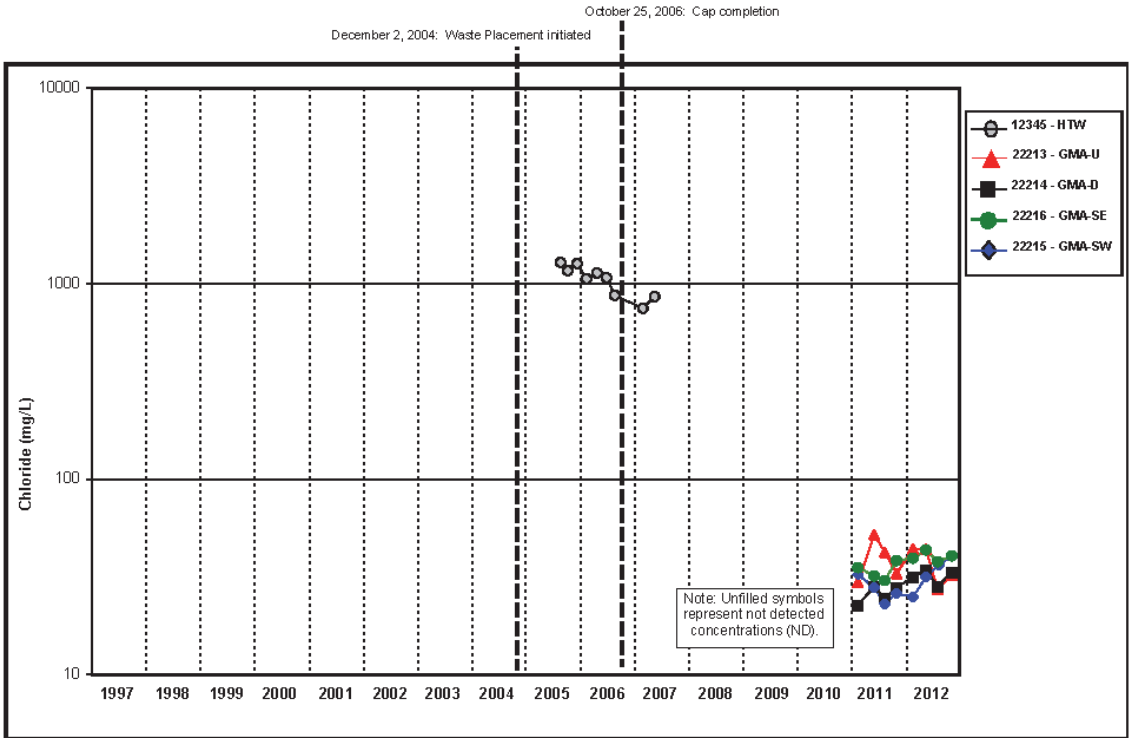


Figure A.5.8–9B. Cell 8 Chloride Concentration vs. Time Plot for HTW, HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

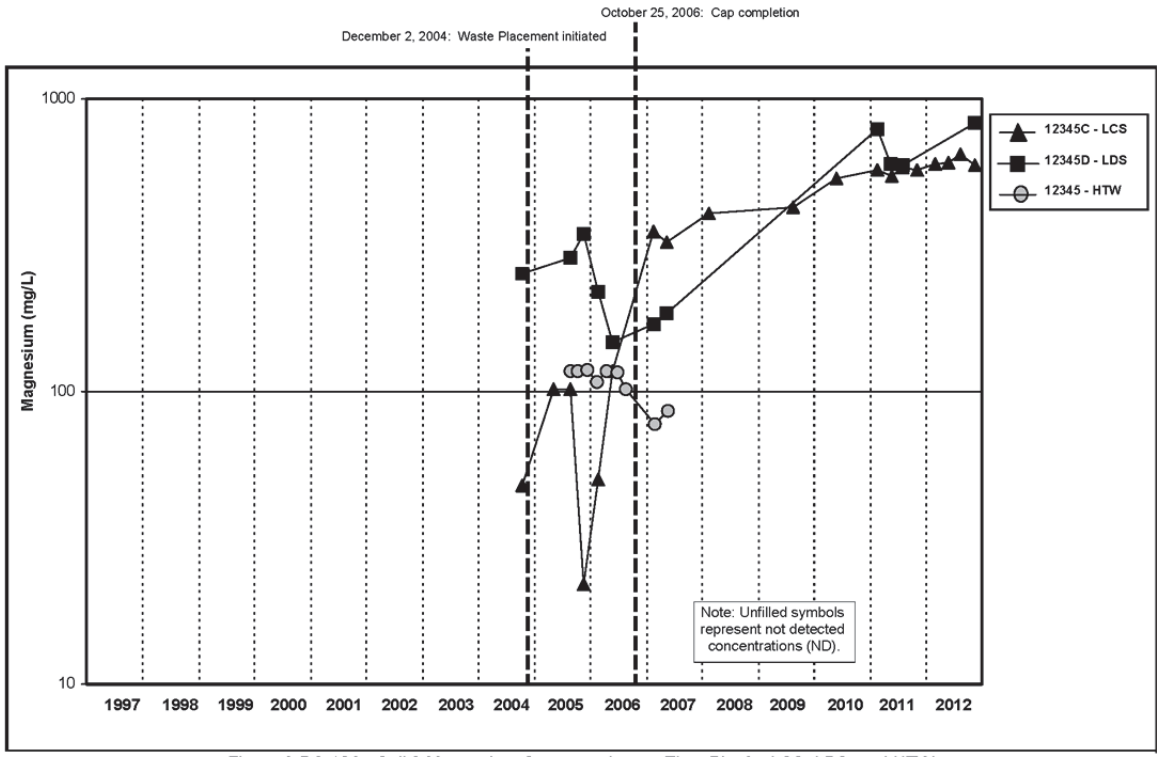


Figure A.5.8–10A. Cell 8 Magnesium Concentration vs. Time Plot for LCS, LDS, and HTW

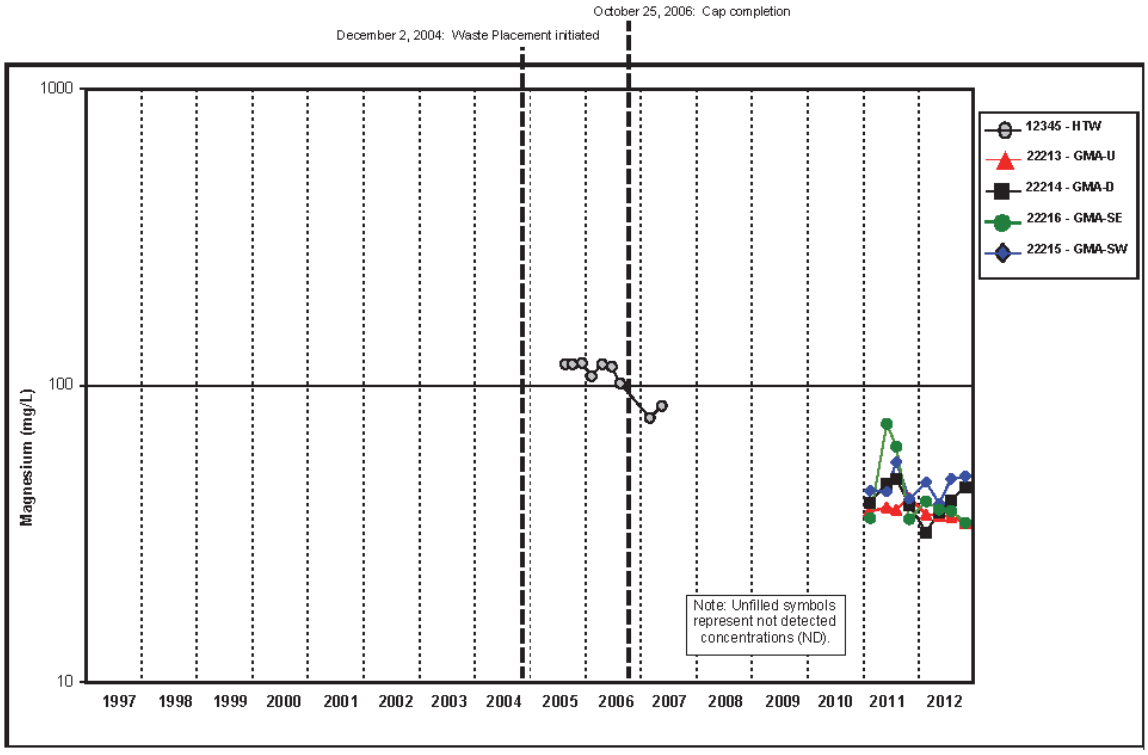


Figure A.5.8–10B. Cell 8 Magnesium Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

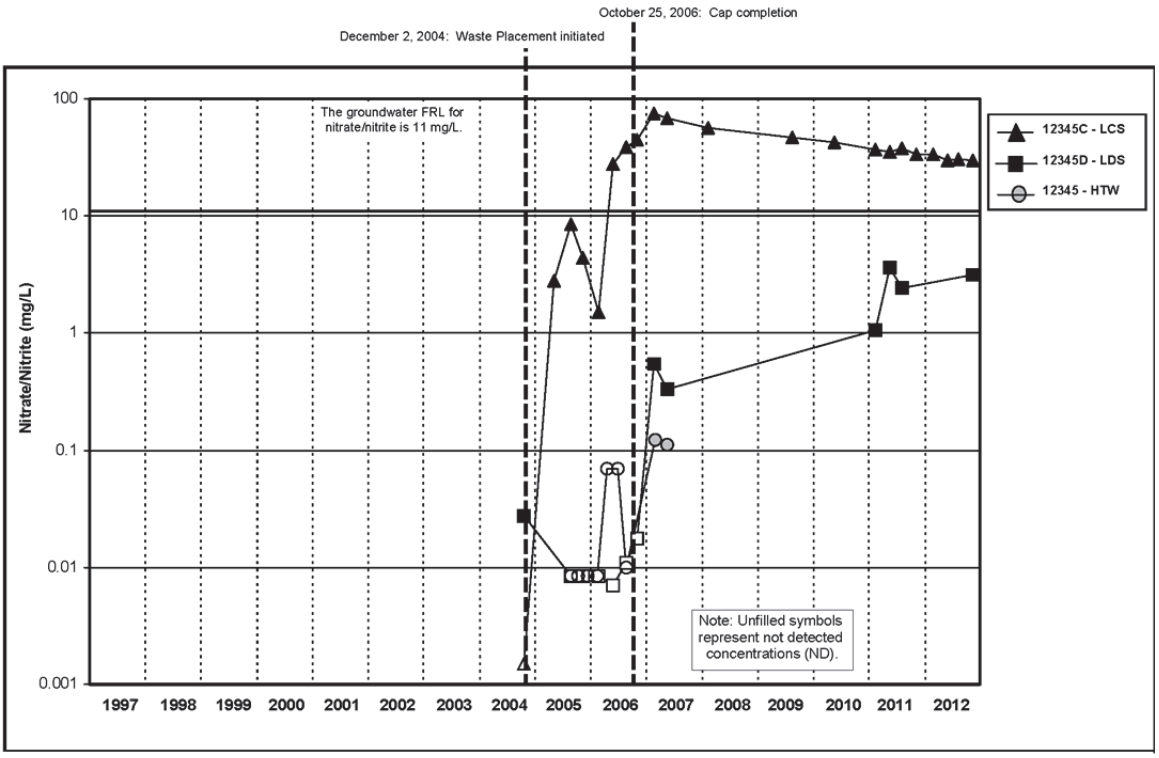


Figure A.5.8–11A. Cell 8 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for LCS, LDS, and HTW

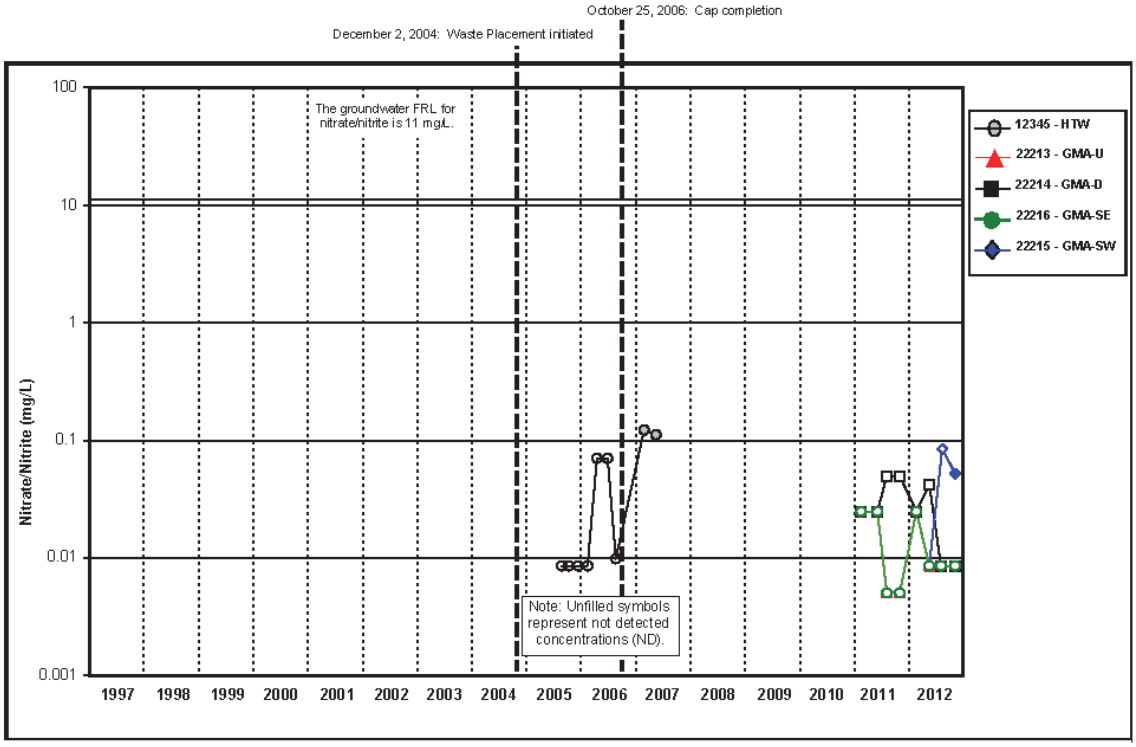


Figure A.5.8–11B. Cell 8 Nitrate + Nitrite as Nitrogen Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

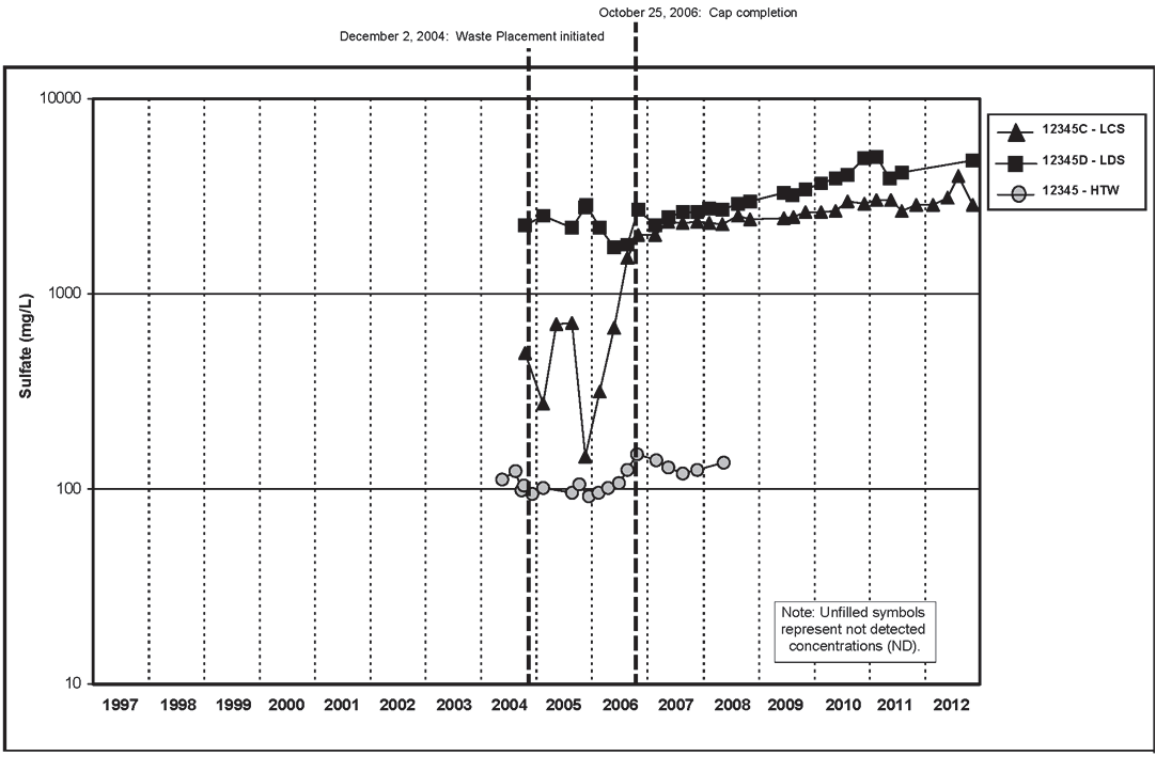


Figure A.5.8–12A. Cell 8 Sulfate Concentration vs. Time Plot for LCS, LDS, and HTW

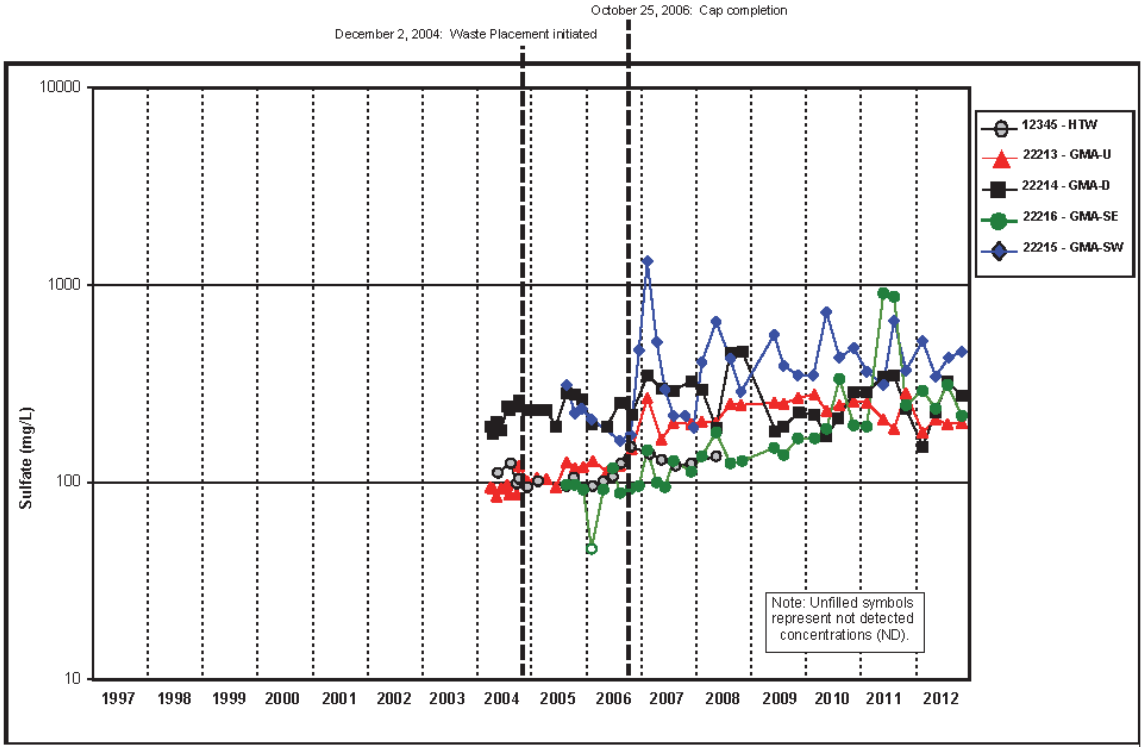


Figure A.5.8–12B. Cell 8 Sulfate Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

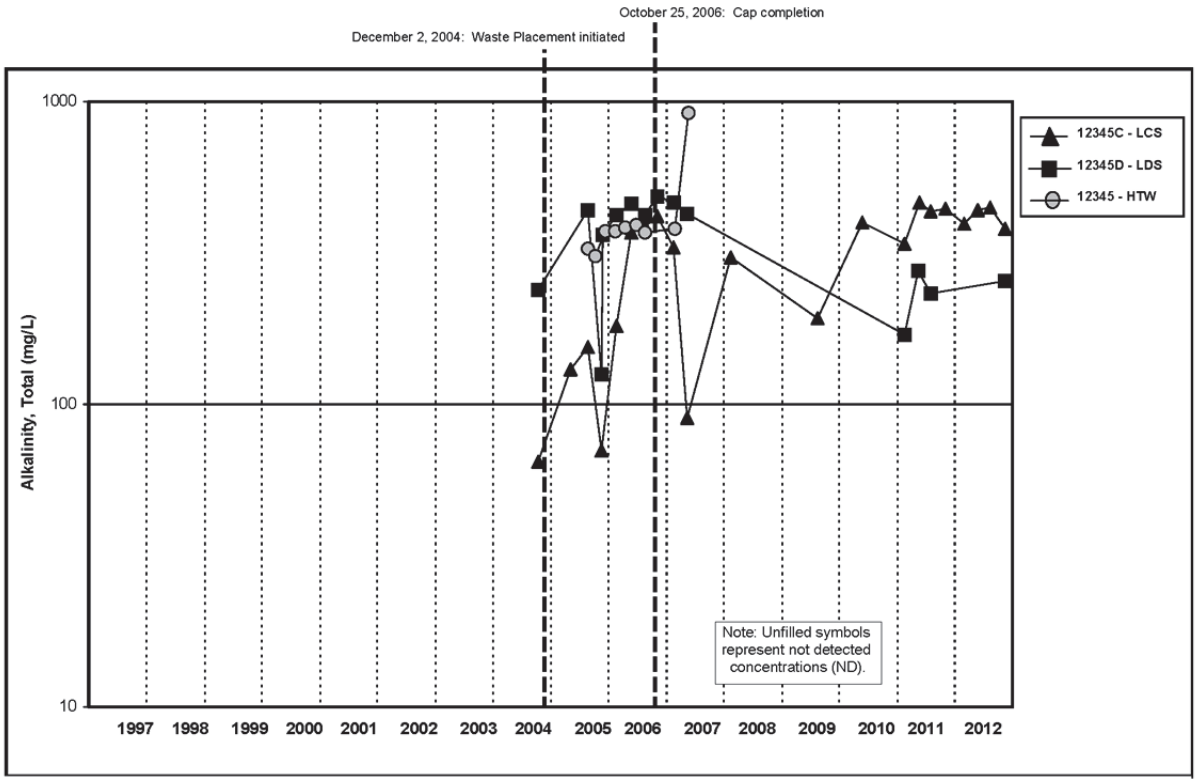


Figure A.5.8–13A. Cell 8 Alkalinity, Total Concentration vs. Time Plot for LCS, LDS, and HTW

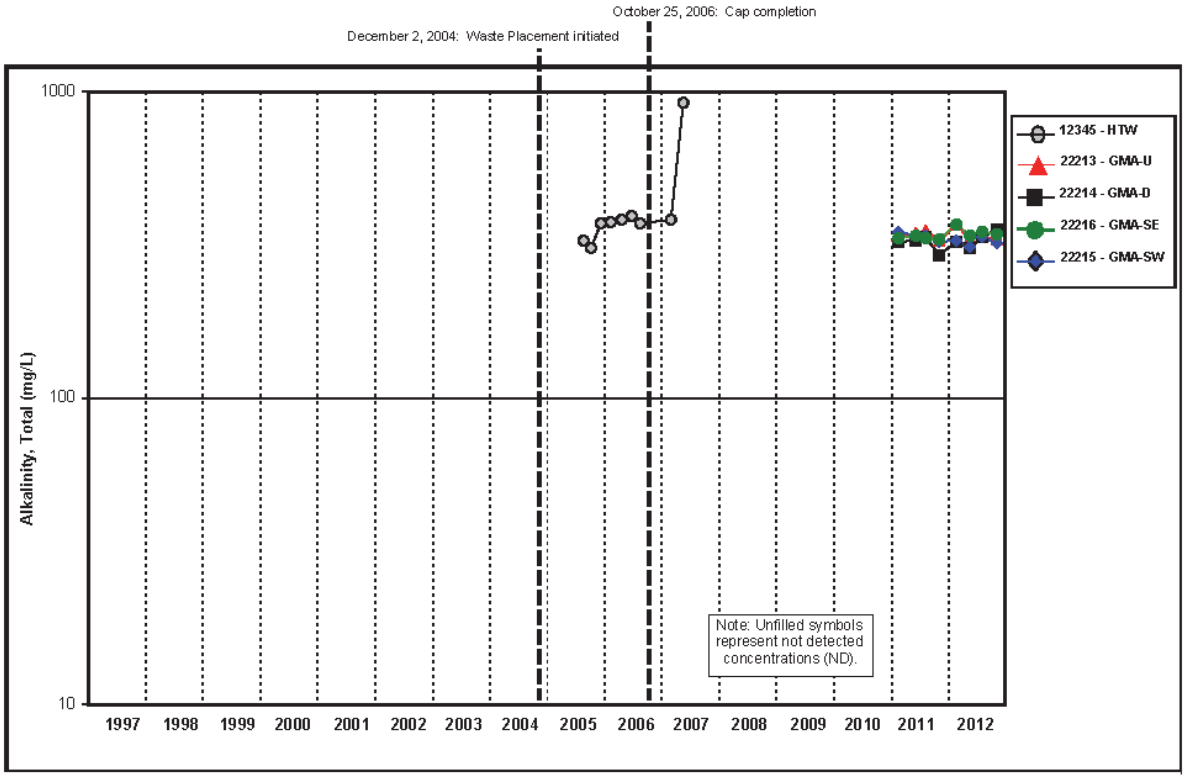


Figure A.5.8–13B. Cell 8 Alkalinity, Total Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

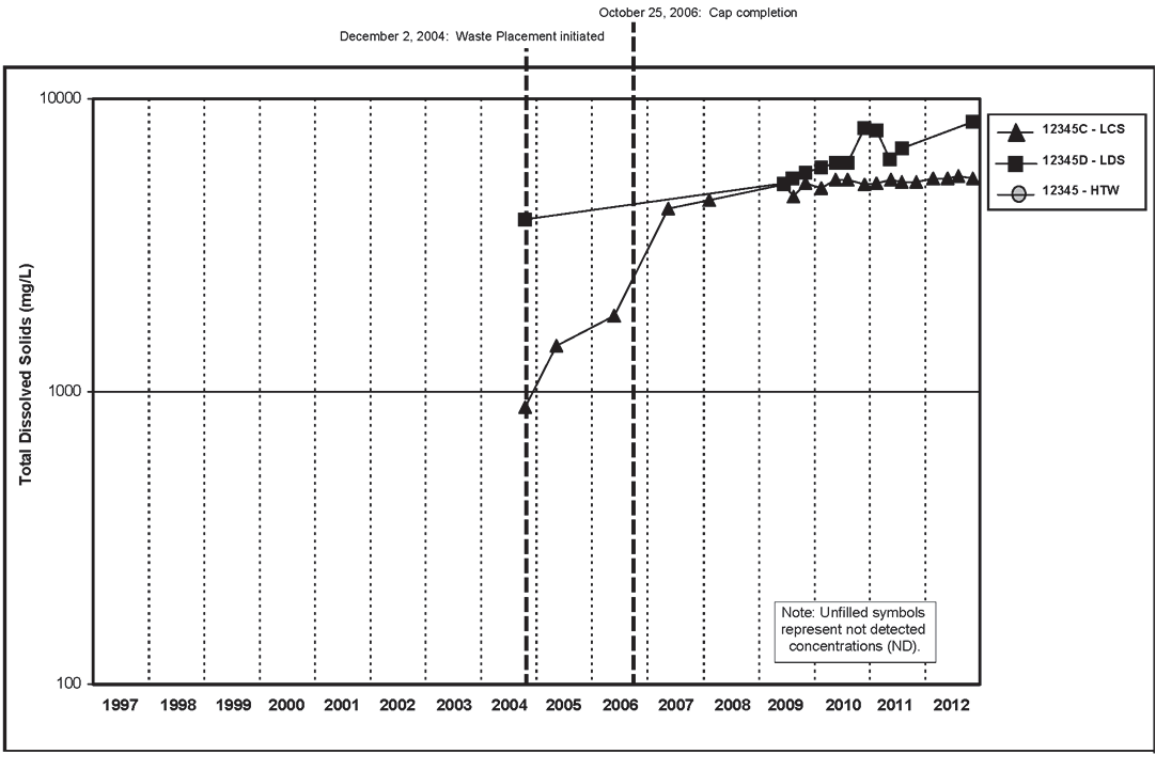


Figure A.5.8–14A. Cell 8 Total Dissolved Solids Concentration vs. Time Plot for LCS, LDS, and HTW

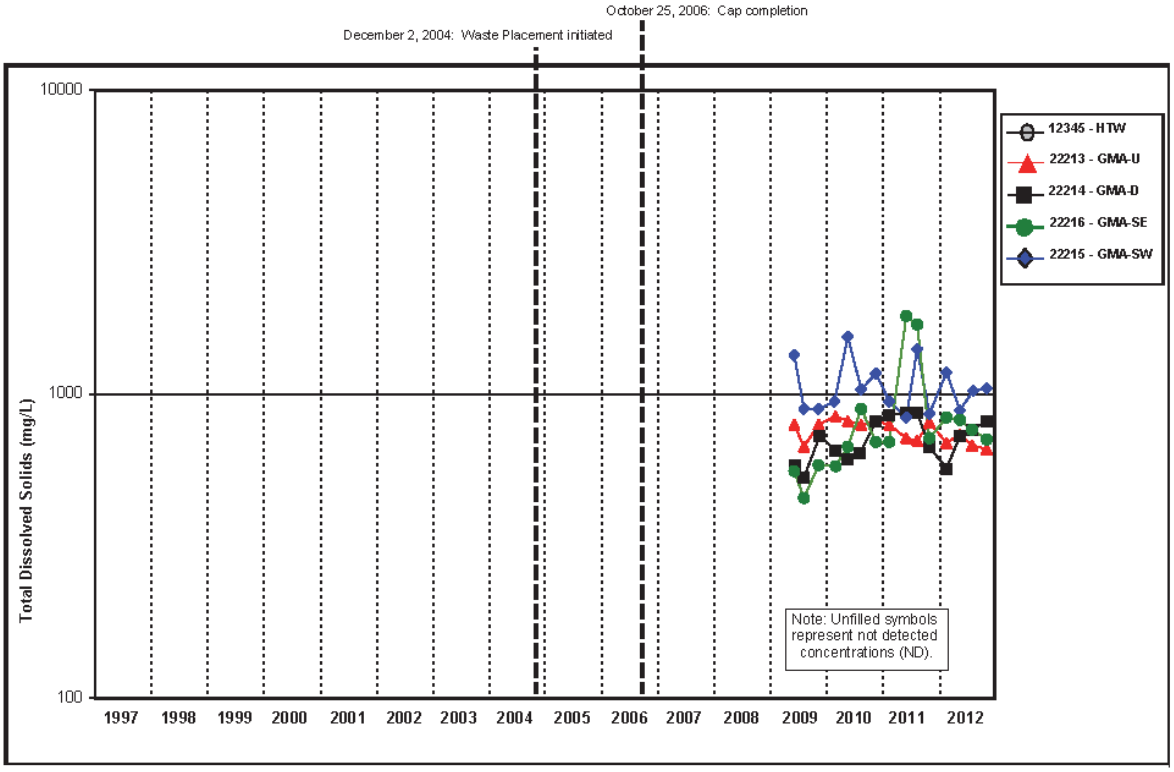


Figure A.5.8–14B. Cell 8 Total Dissolved Solids Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

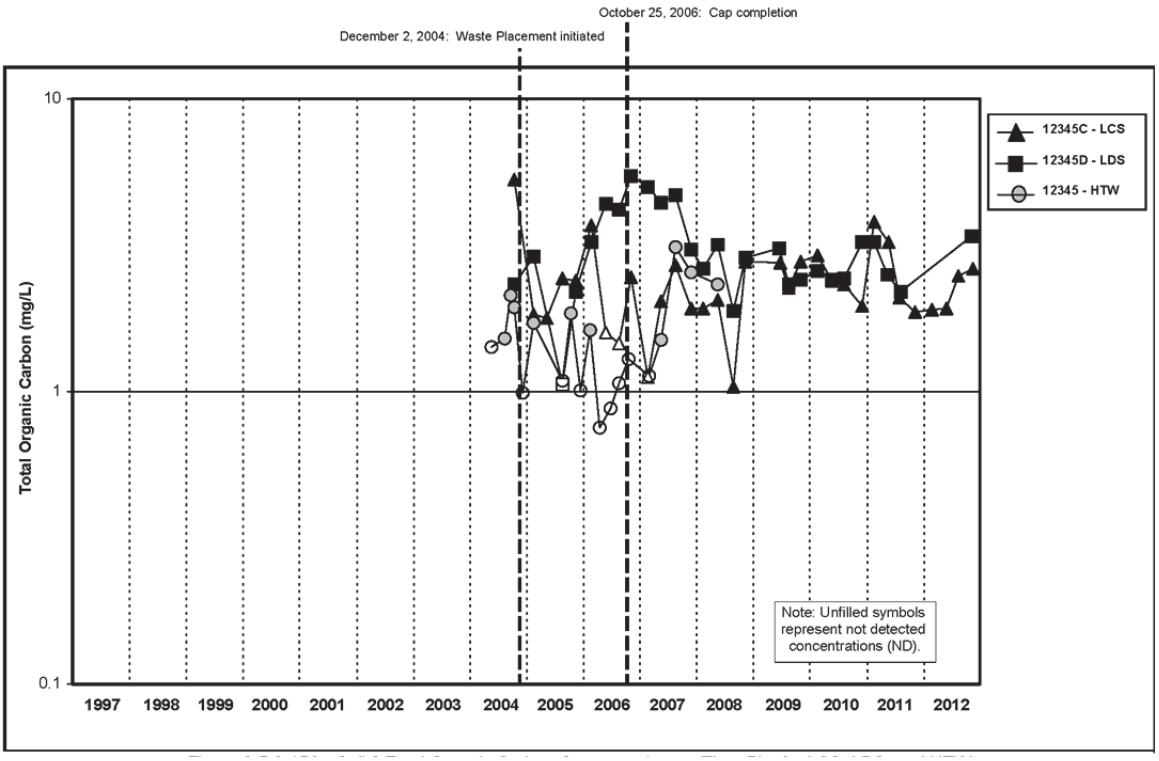


Figure A.5.8– 15A. Cell 8 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, and HTW

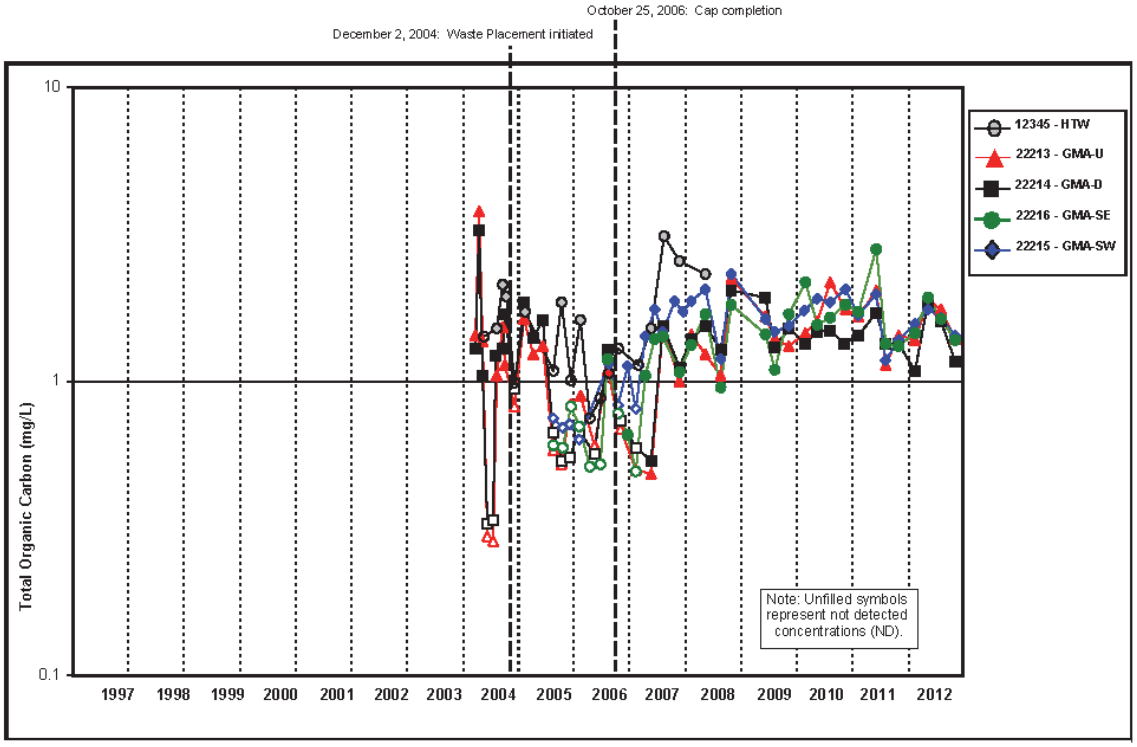


Figure A.5.8–15B. Cell 8 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

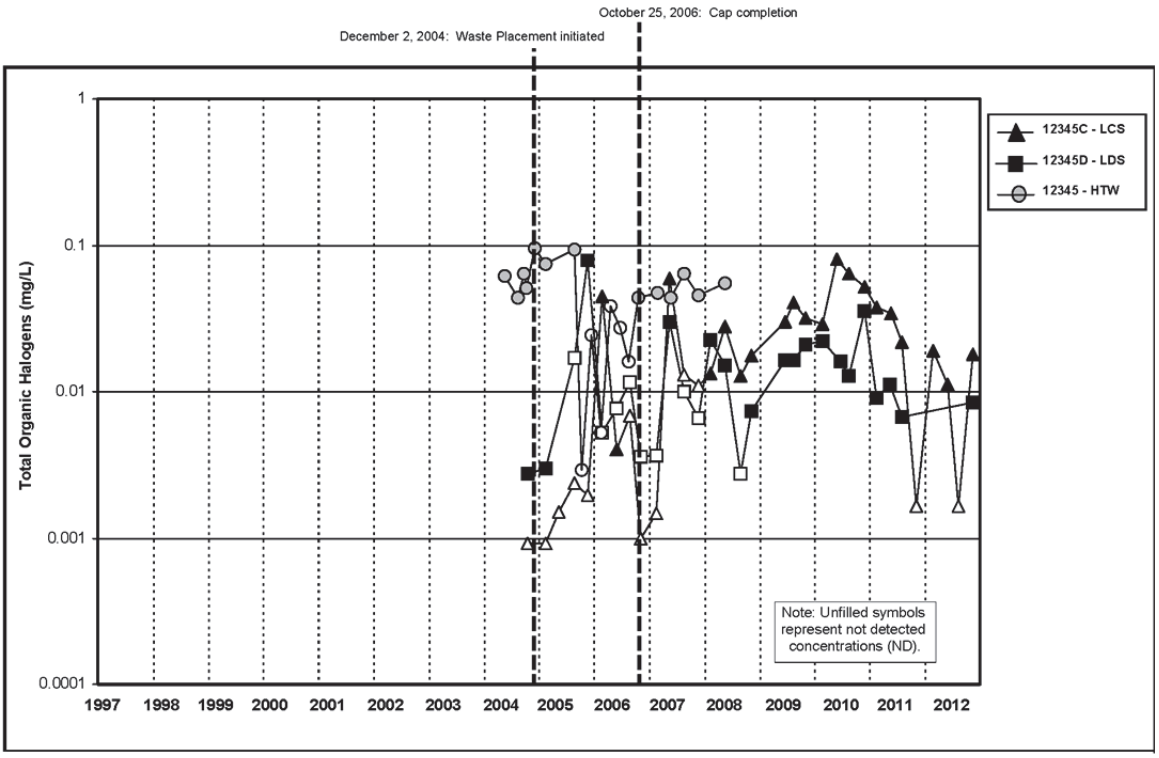


Figure A.5.8–16A. Cell 8 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, and HTW

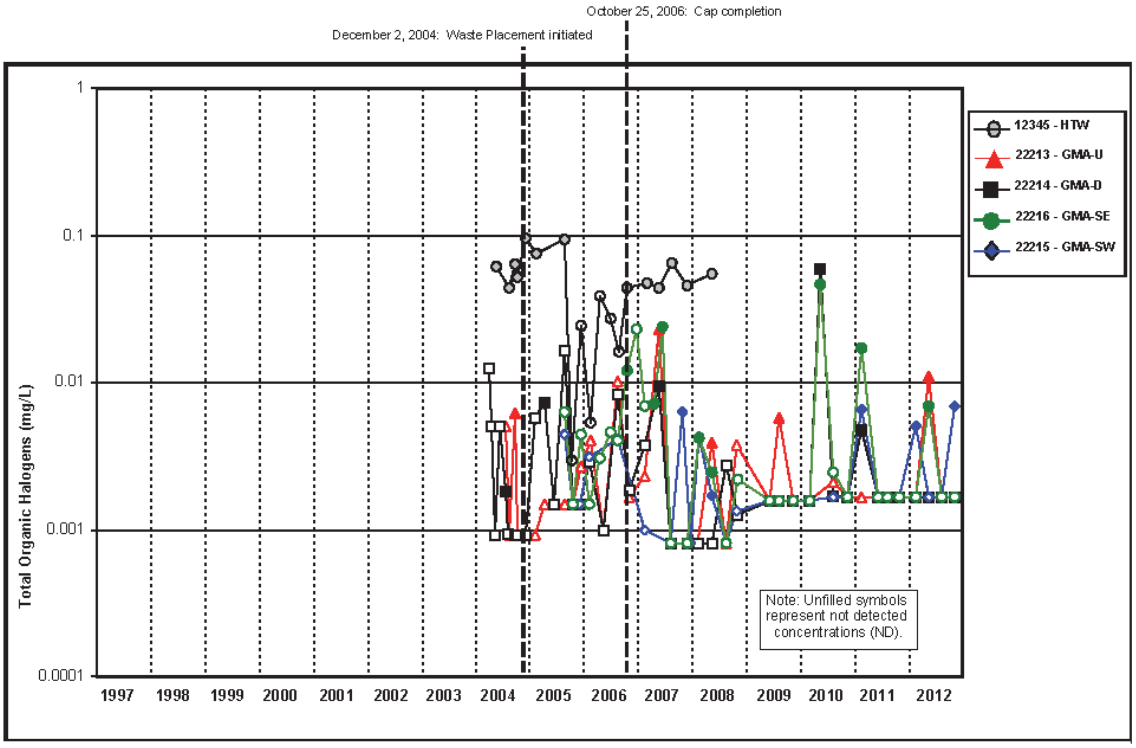


Figure A.5.8–16B. Cell 8 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

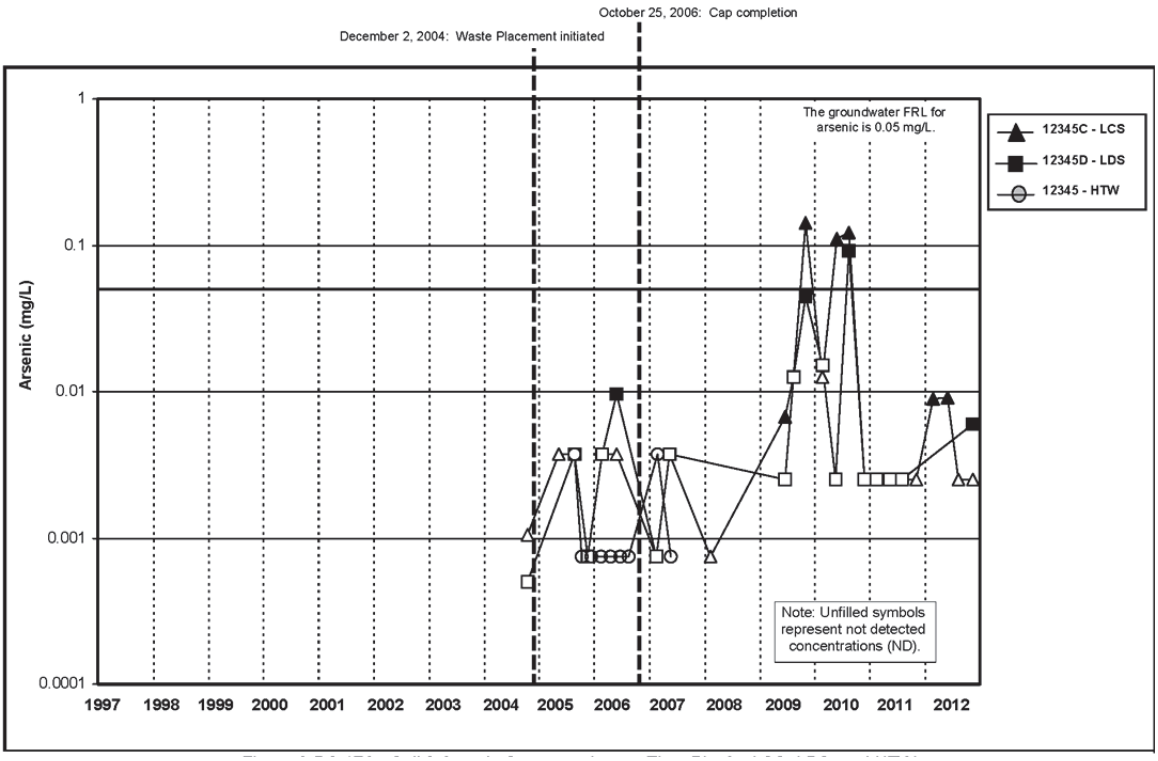


Figure A.5.8–17A. Cell 8 Arsenic Concentration vs. Time Plot for LCS, LDS, and HTW

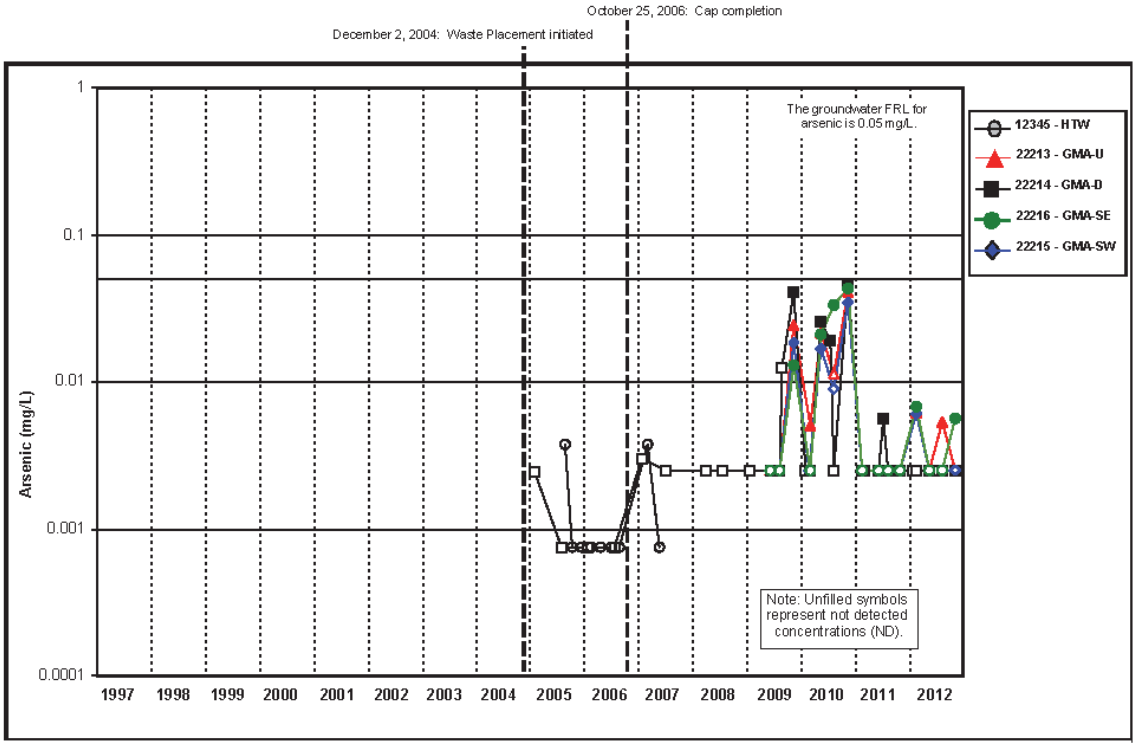


Figure A.5.8–17B. Cell 8 Arsenic Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

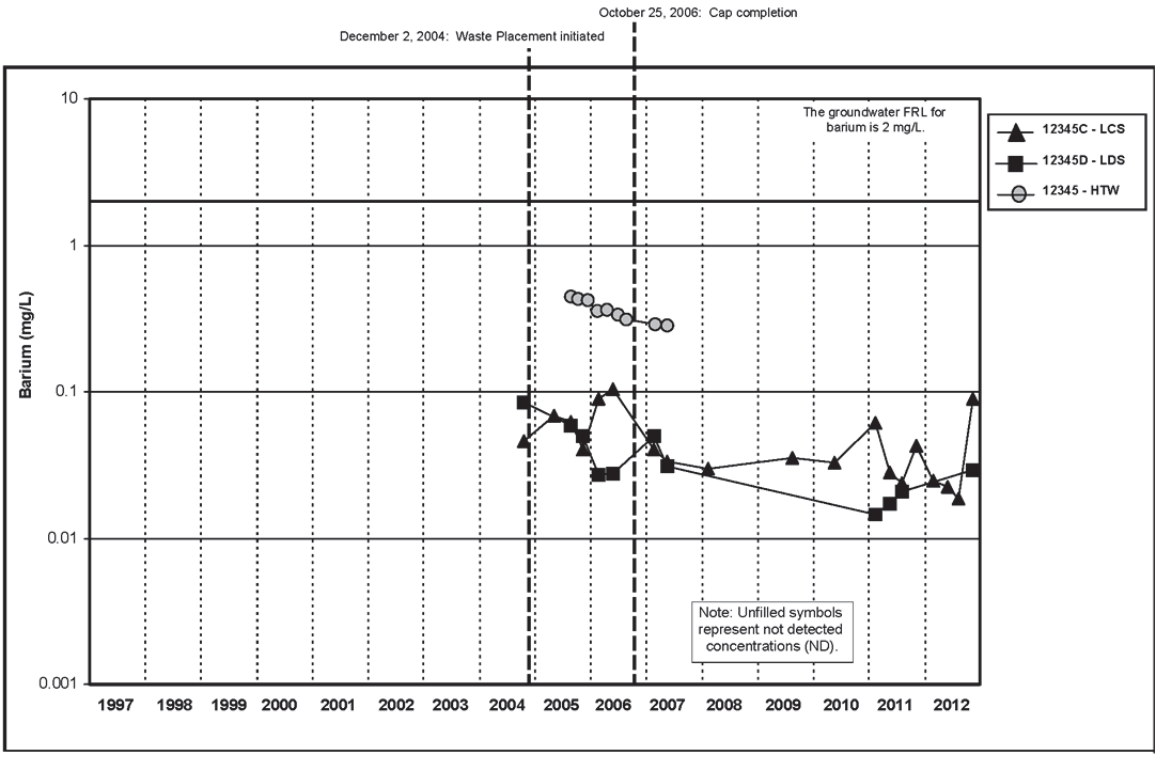


Figure A.5.8–18A. Cell 8 Barium Concentration vs. Time Plot for LCS, LDS, and HTW

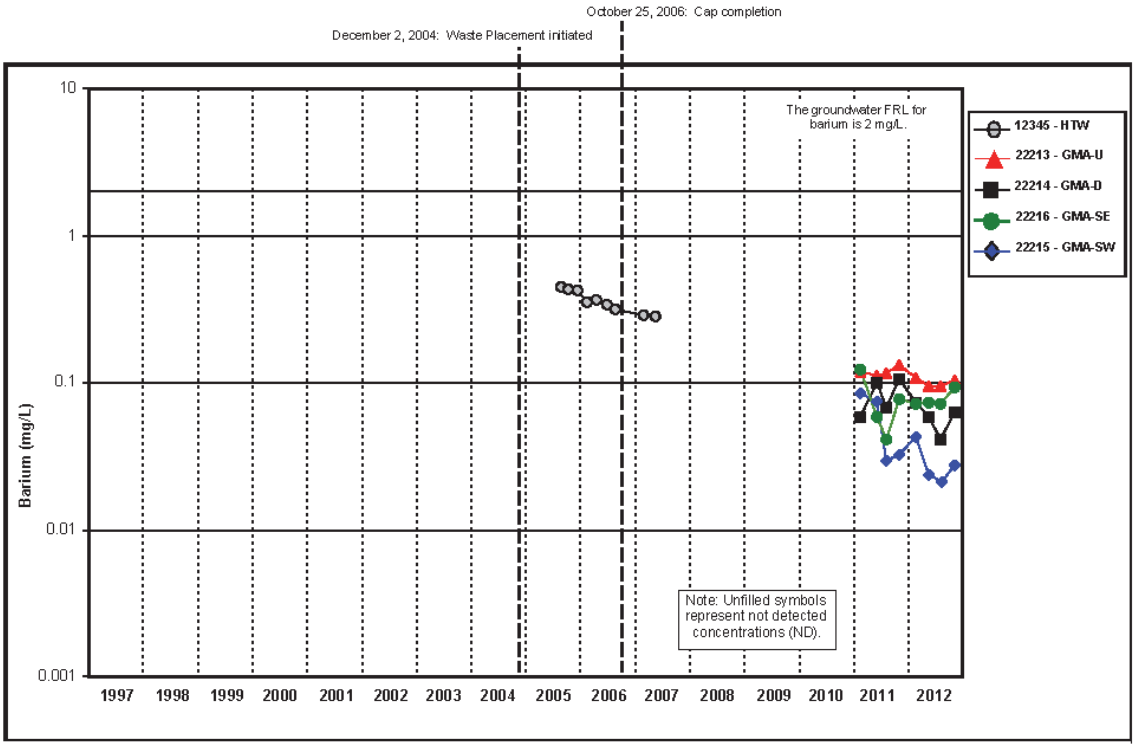


Figure A.5.8–18B. Cell 8 Barium Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

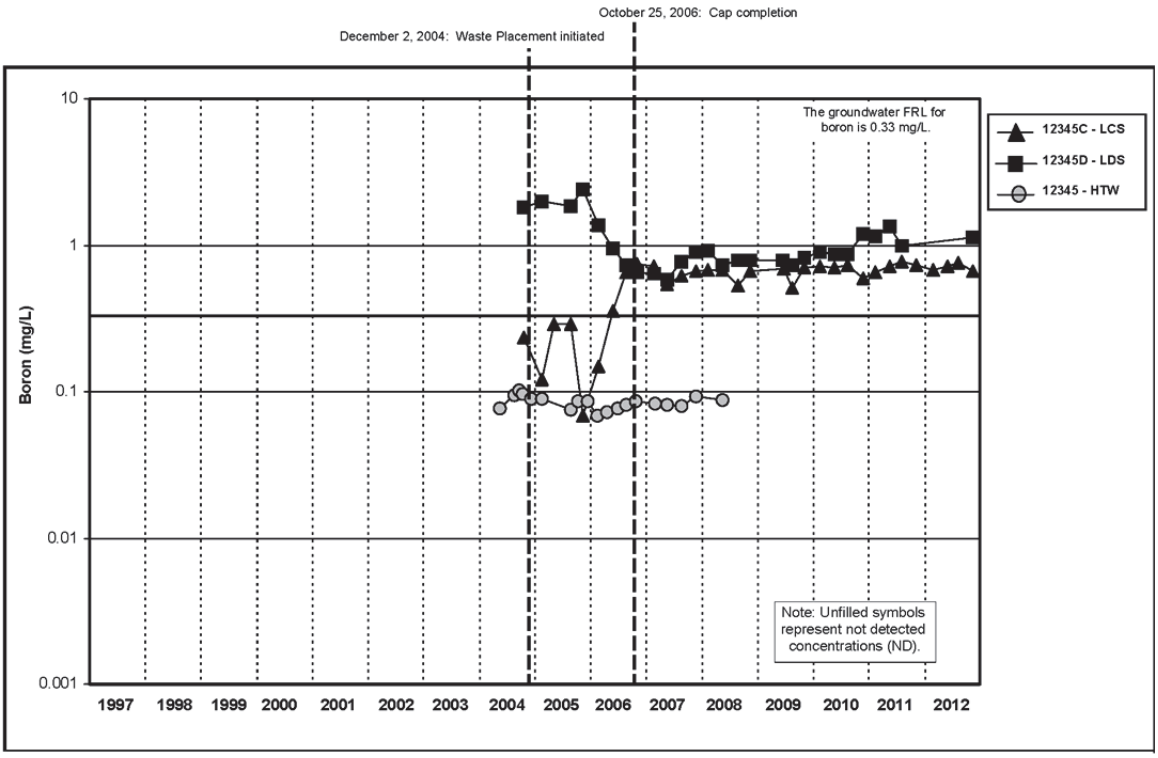


Figure A.5.8–19A. Cell 8 Boron Concentration vs. Time Plot for LCS, LDS, and HTW

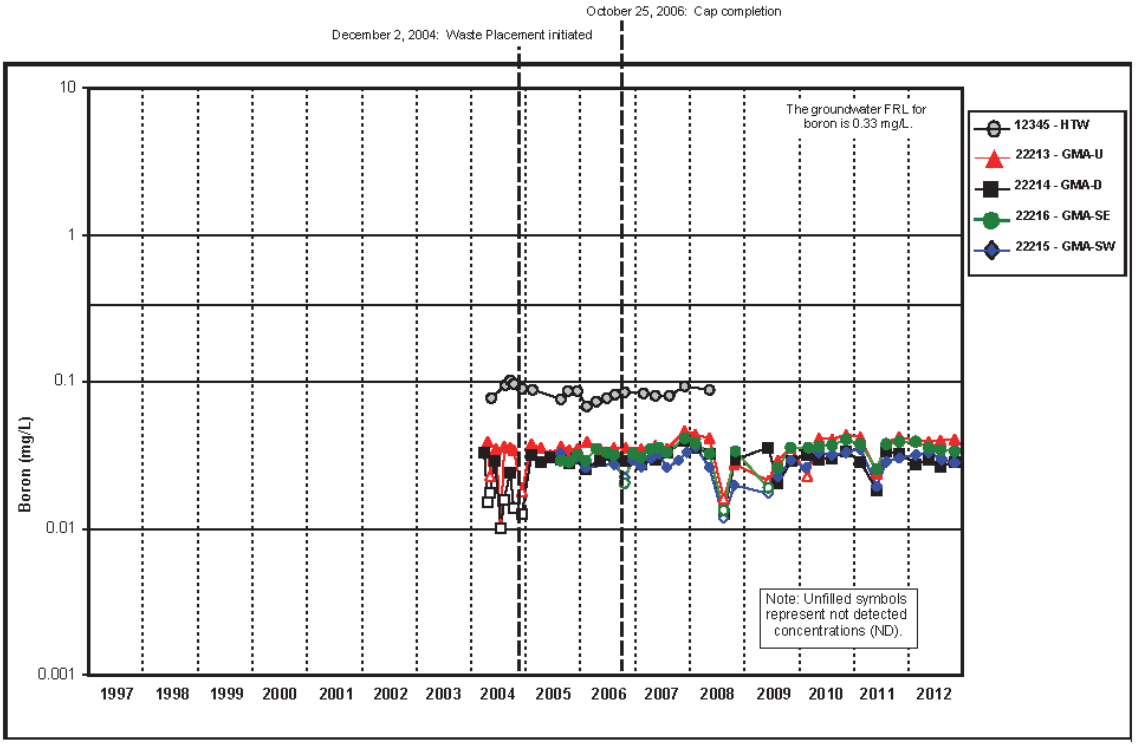


Figure A.5.8–19B. Cell 8 Boron Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

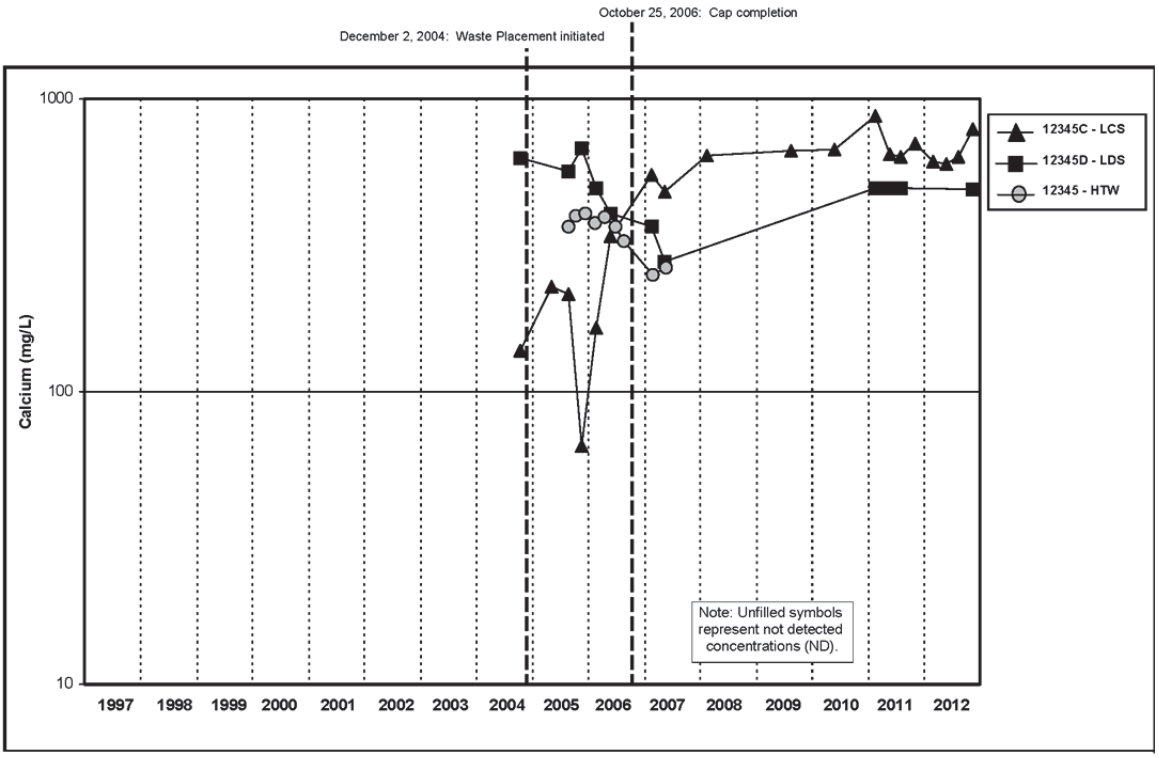


Figure A.5.8–20A. Cell 8 Calcium Concentration vs. Time Plot for LCS, LDS, and HTW

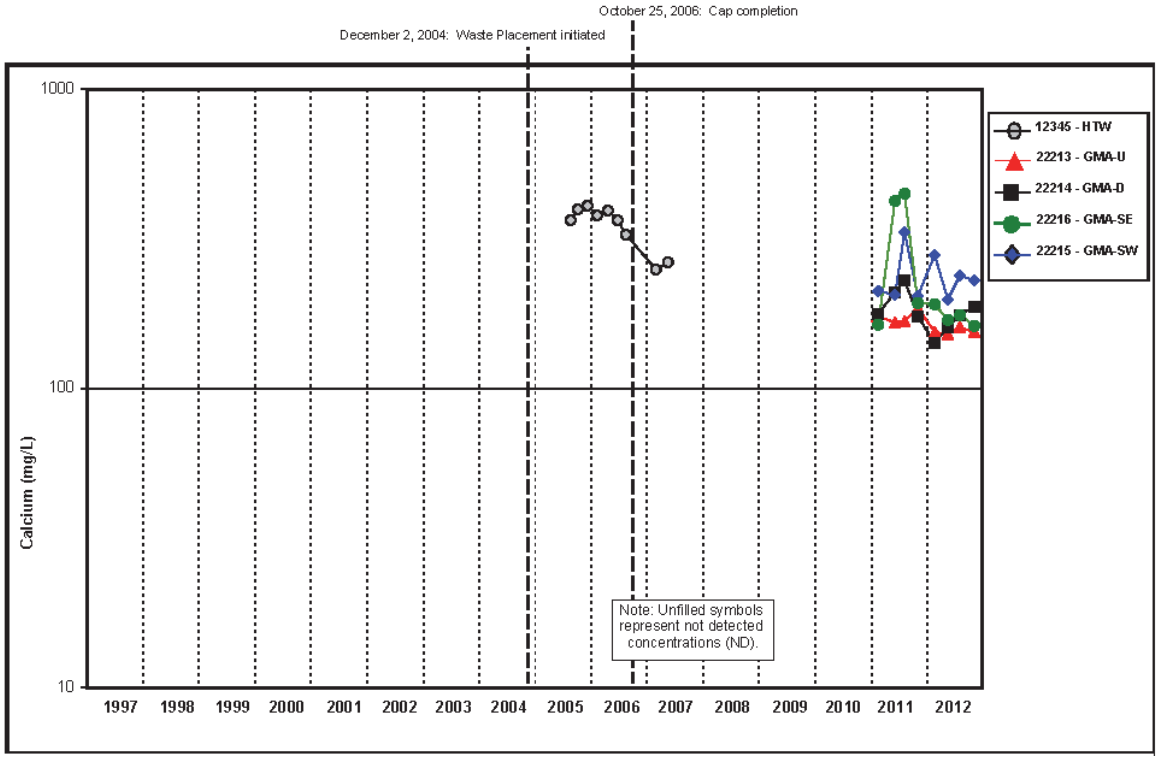


Figure A.5.8–20B. Cell 8 Calcium Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

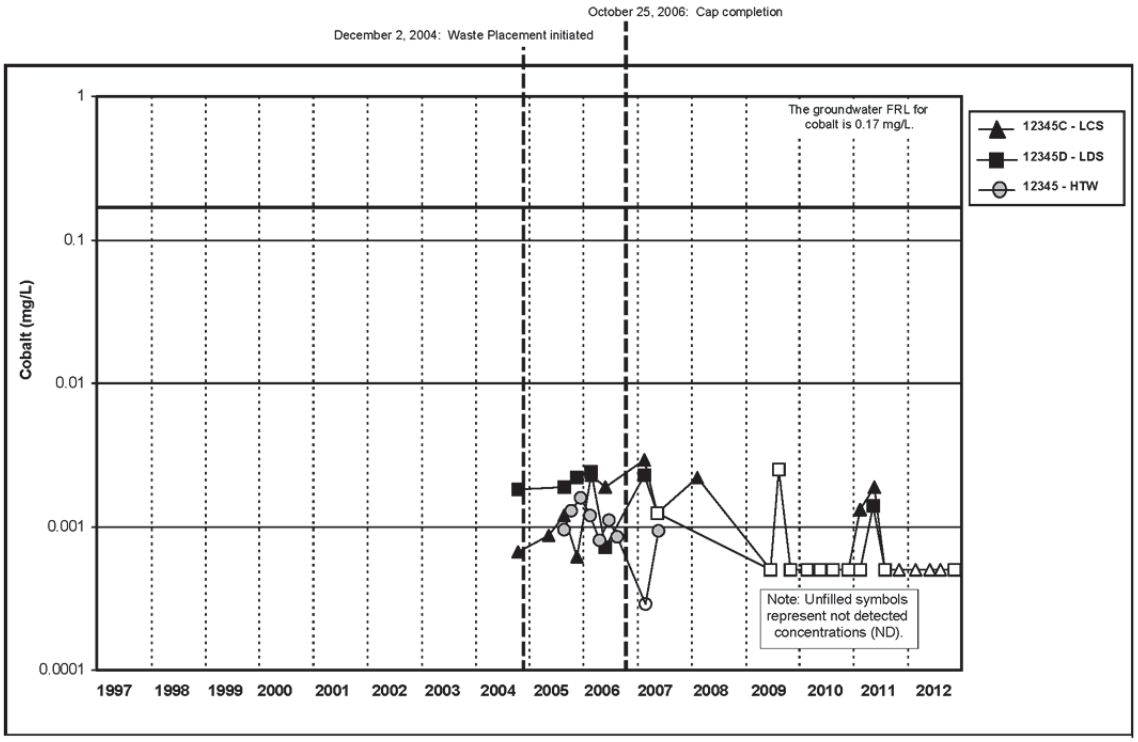


Figure A.5.8–21A. Cell 8 Cobalt Concentration vs. Time Plot for LCS, LDS, and HTW

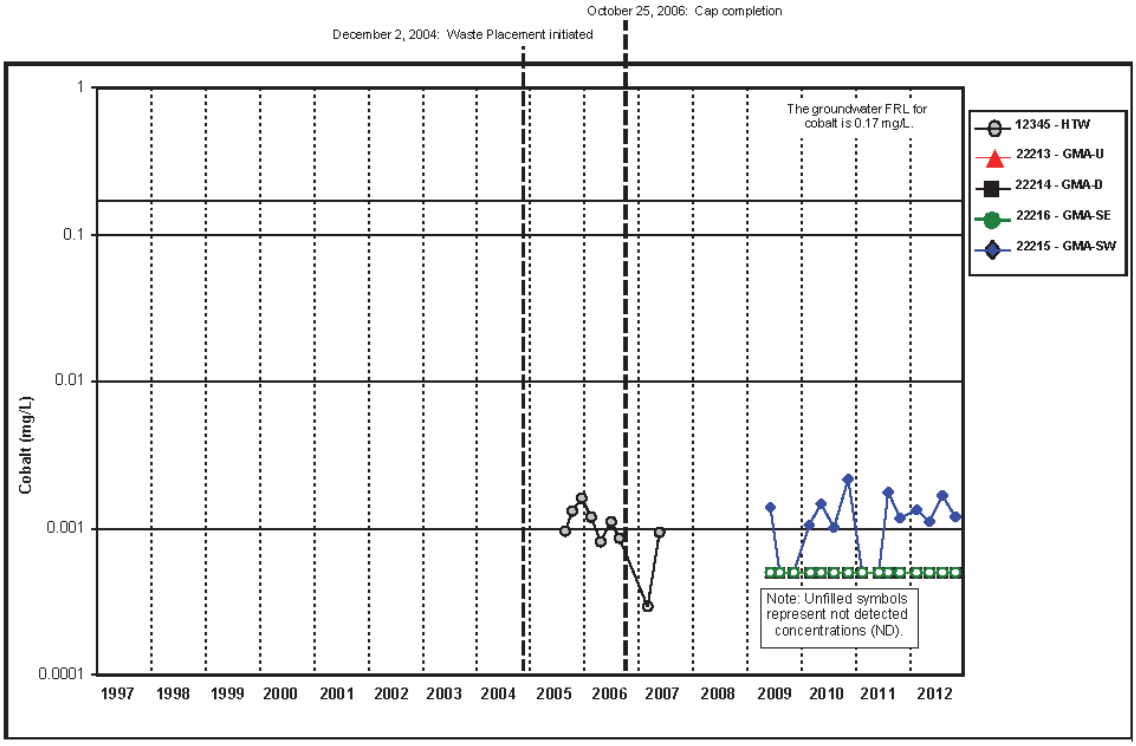


Figure A.5.8–21B. Cell 8 Cobalt Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

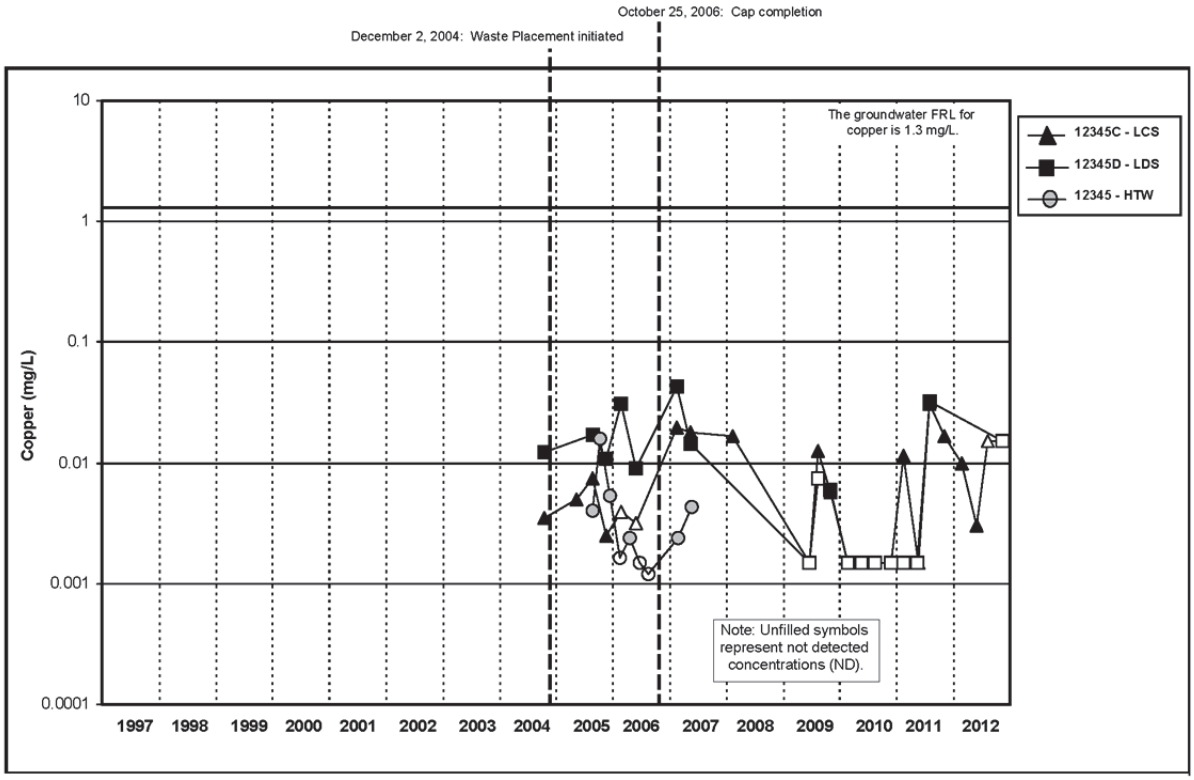


Figure A.5.8–22A. Cell 8 Copper Concentration vs. Time Plot for LCS, LDS, and HTW

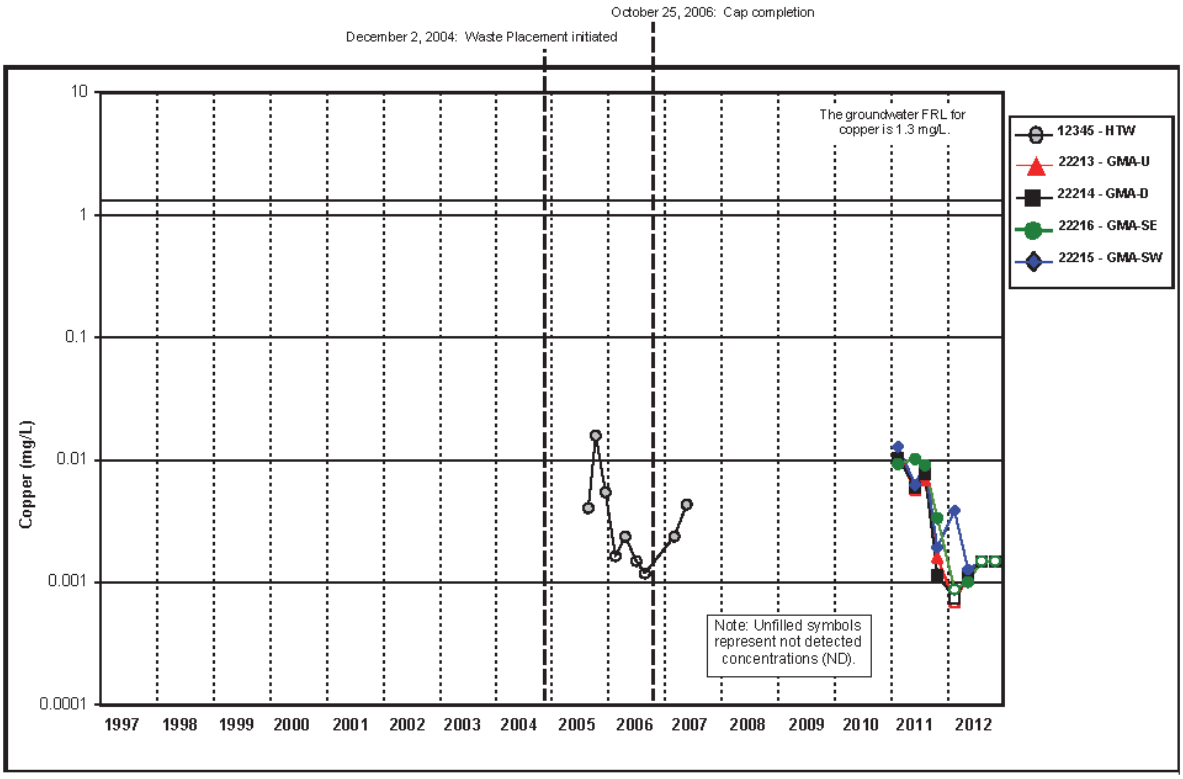


Figure A.5.8–22B. Cell 8 Copper Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

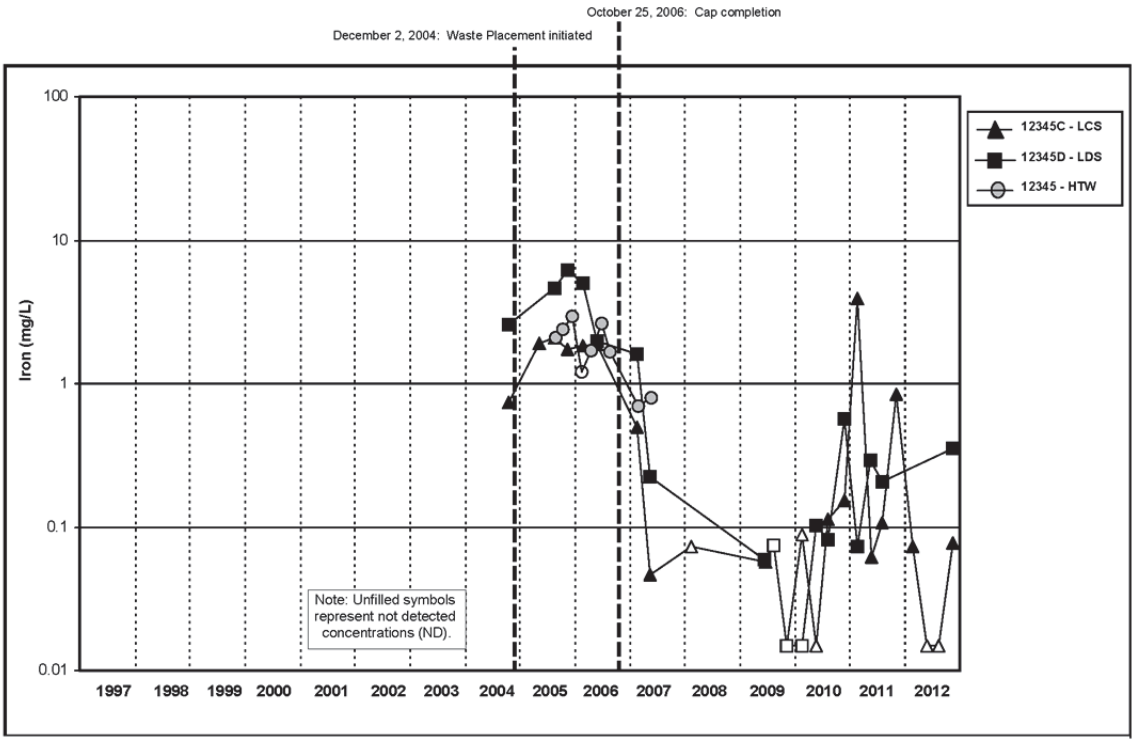


Figure A.5.8–23A. Cell 8 Iron Concentration vs. Time Plot for LCS, LDS, and HTW

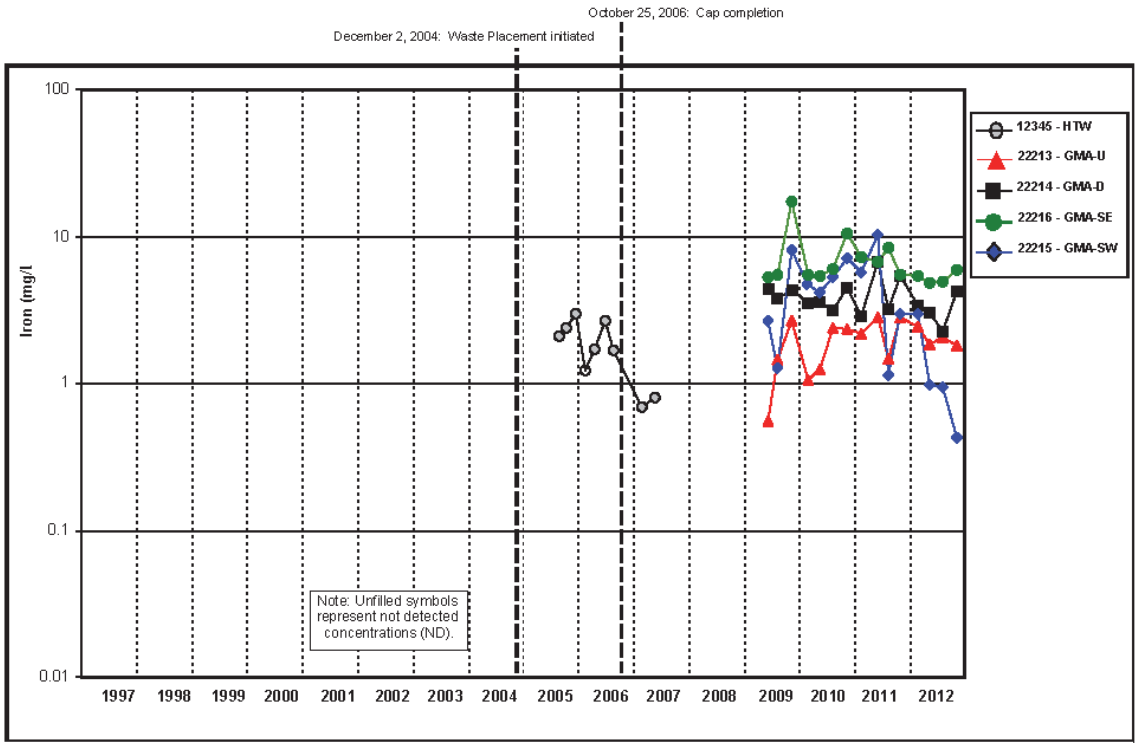


Figure A.5.8–23B. Cell 8 Iron Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

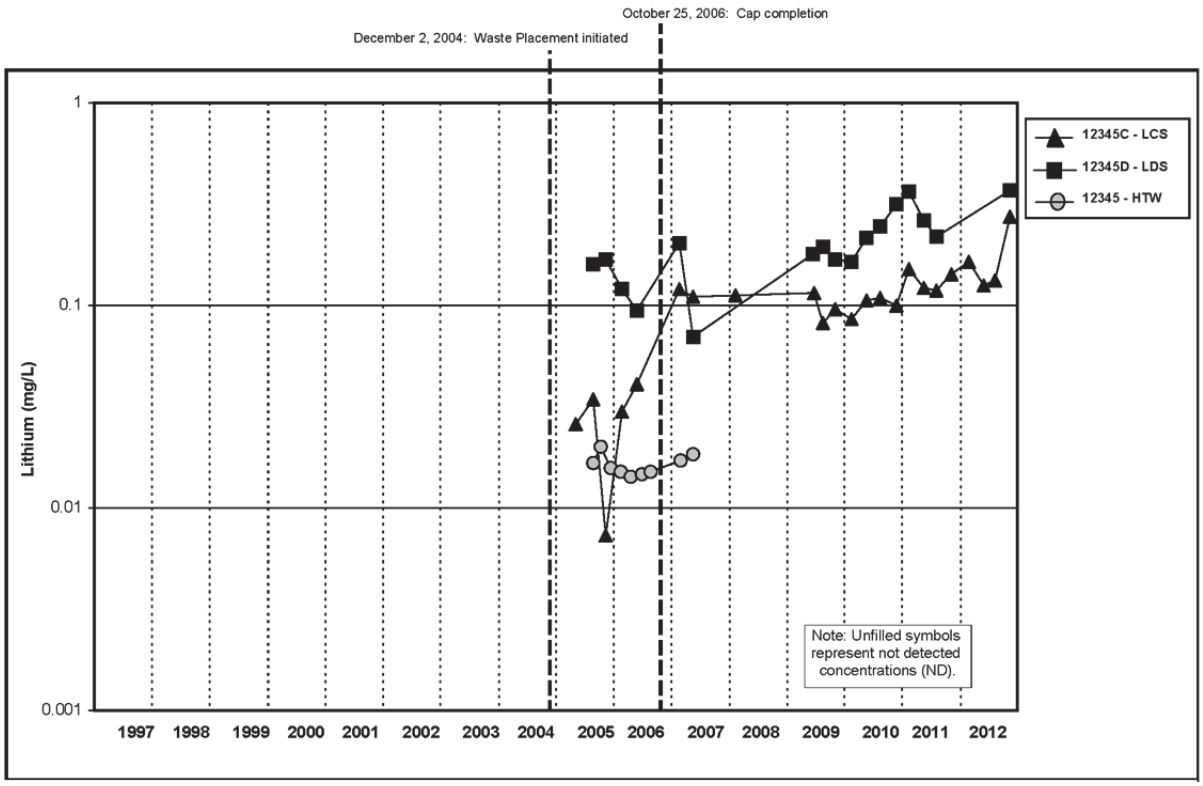


Figure A.5.8–24A. Cell 8 Lithium Concentration vs. Time Plot for LCS, LDS, and HTW

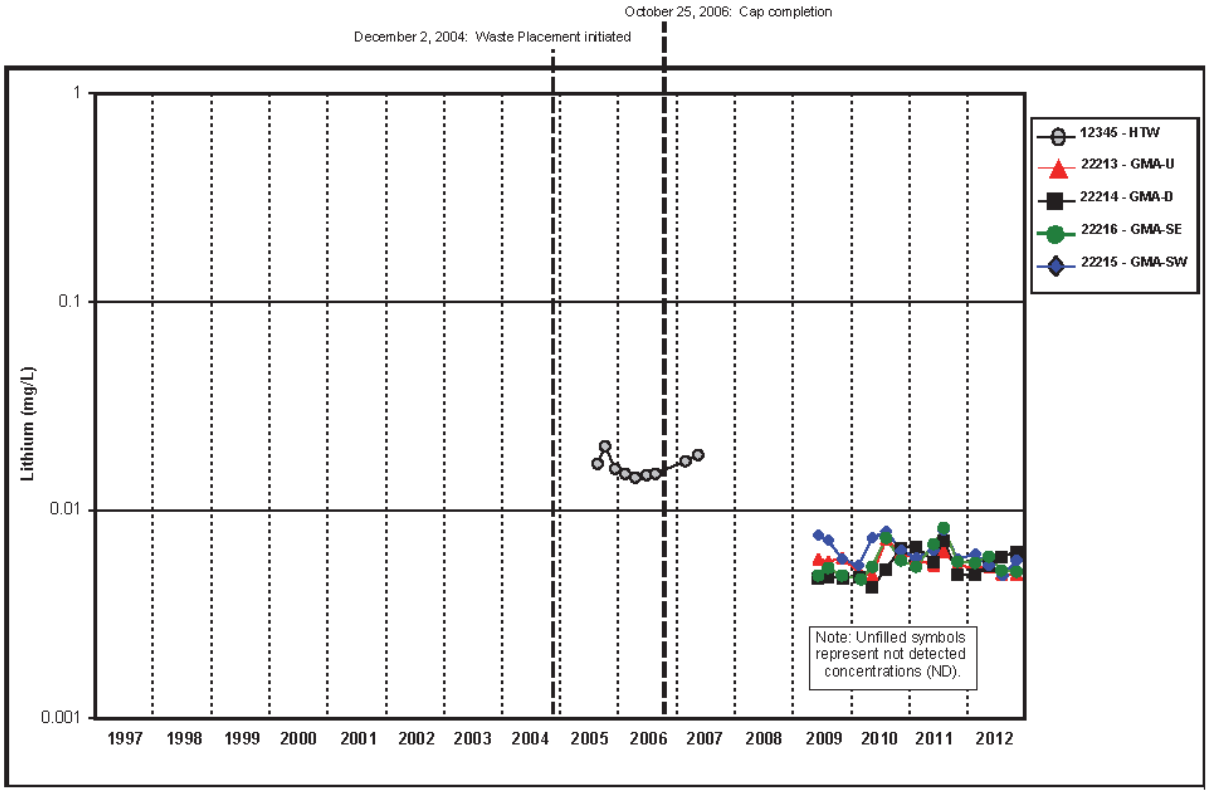


Figure A.5.8–24B. Cell 8 Lithium Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

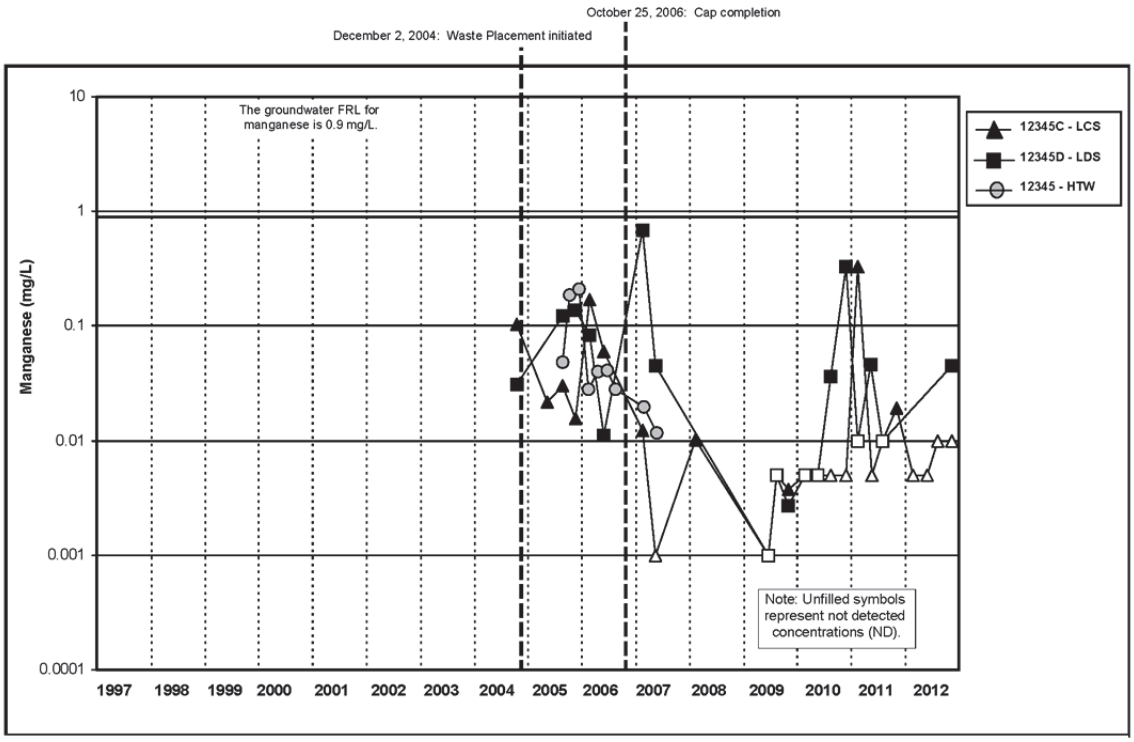


Figure A.5.8–25A. Cell 8 Manganese Concentration vs. Time Plot for LCS, LDS, and HTW

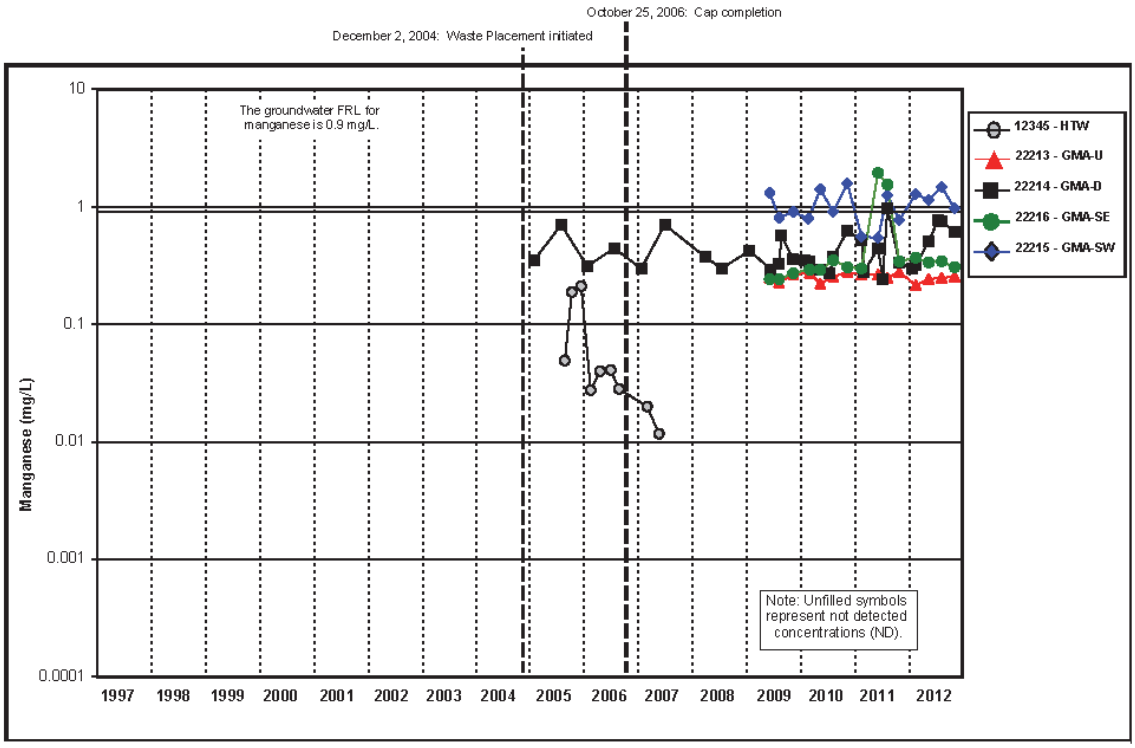


Figure A.5.8–25B. Cell 8 Manganese Concentration vs. Time Plot for HTW, GMA-U Well, GMA-D, GMA-SE, and GMA-SW Wells

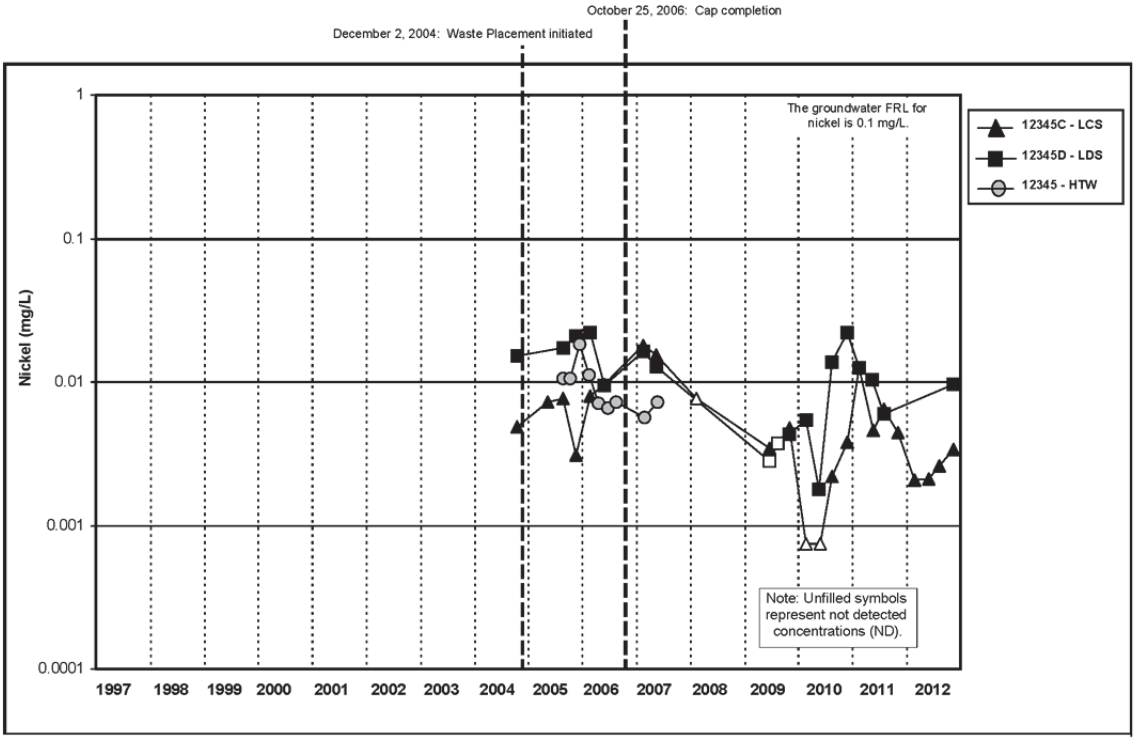


Figure A.5.8–26A. Cell 8 Nickel Concentration vs. Time Plot for LCS, LDS, and HTW

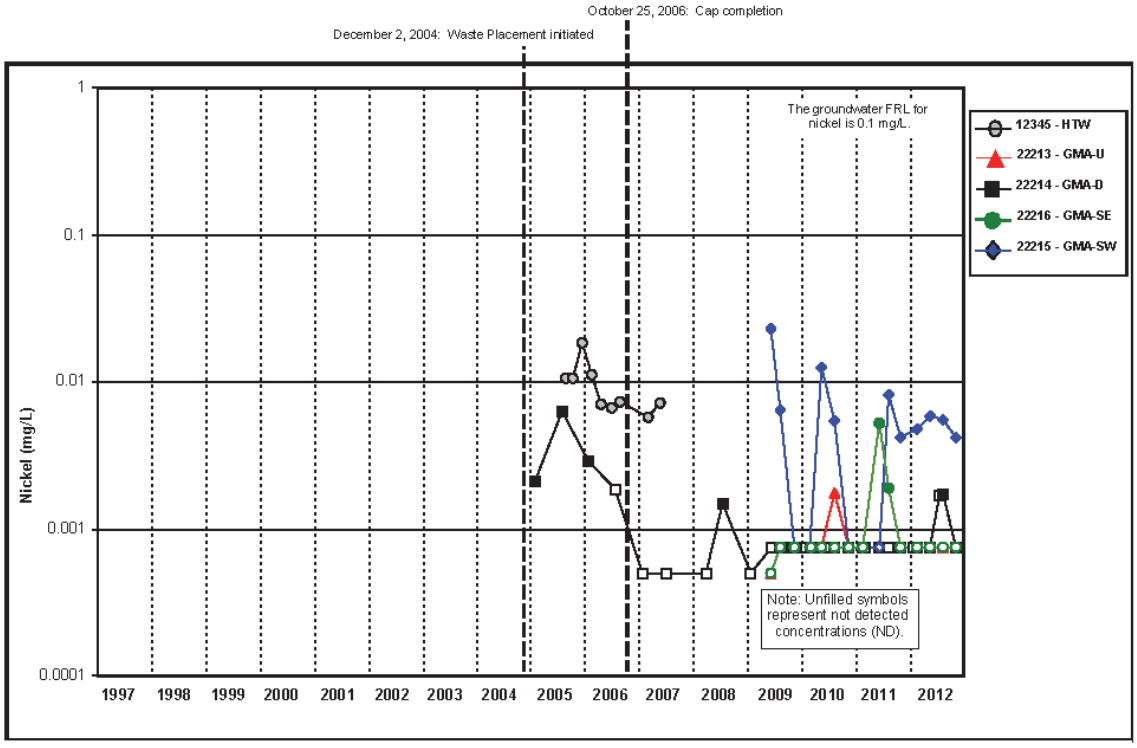


Figure A.5.8–26B. Cell 8 Nickel Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

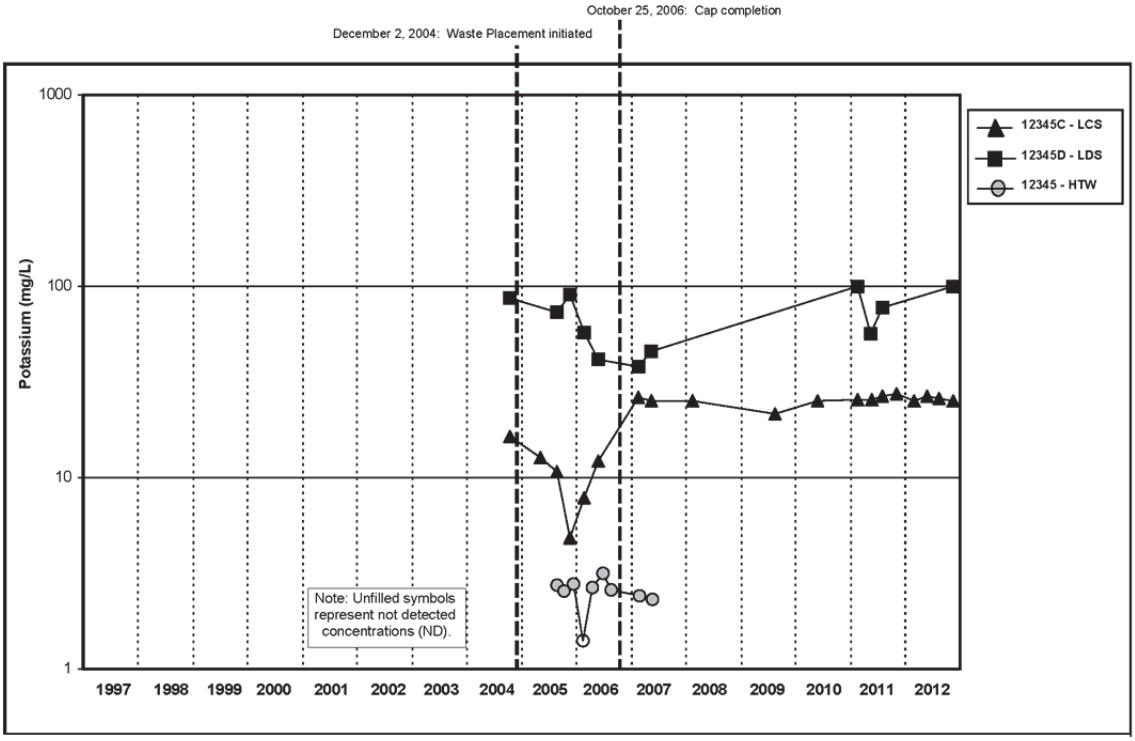


Figure A.5.8–27A. Cell 8 Potassium Concentration vs. Time Plot for LCS, LDS, and HTW

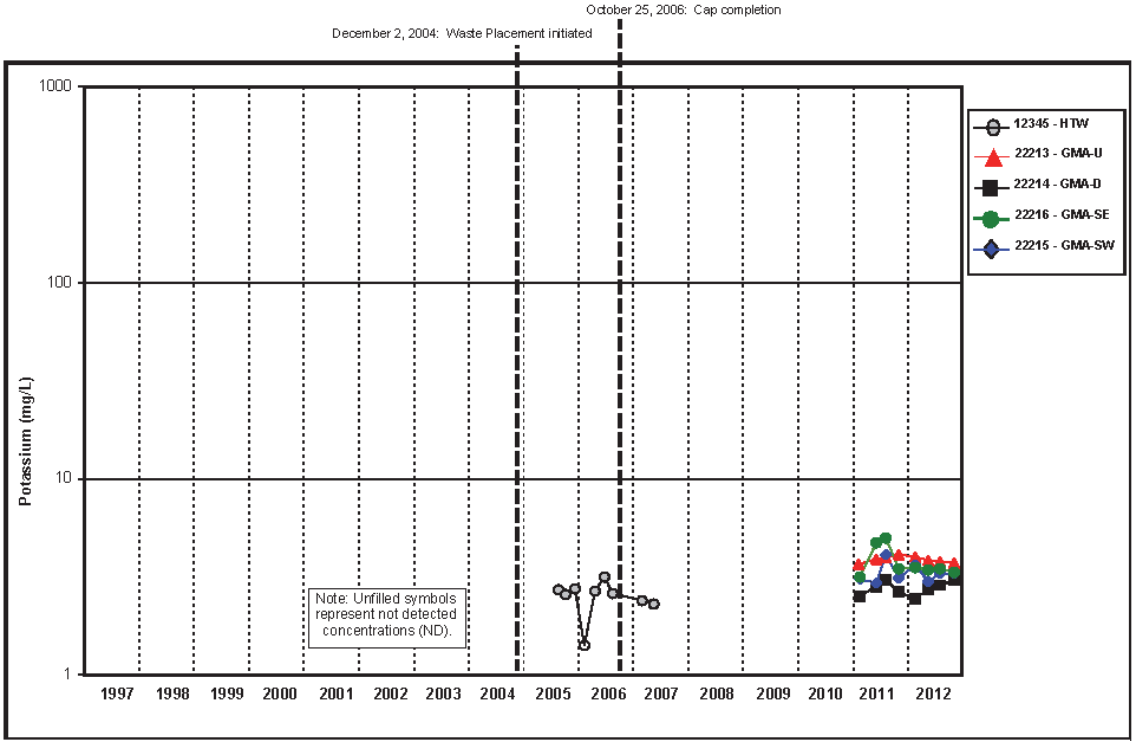


Figure A.5.8–27B. Cell 8 Potassium Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

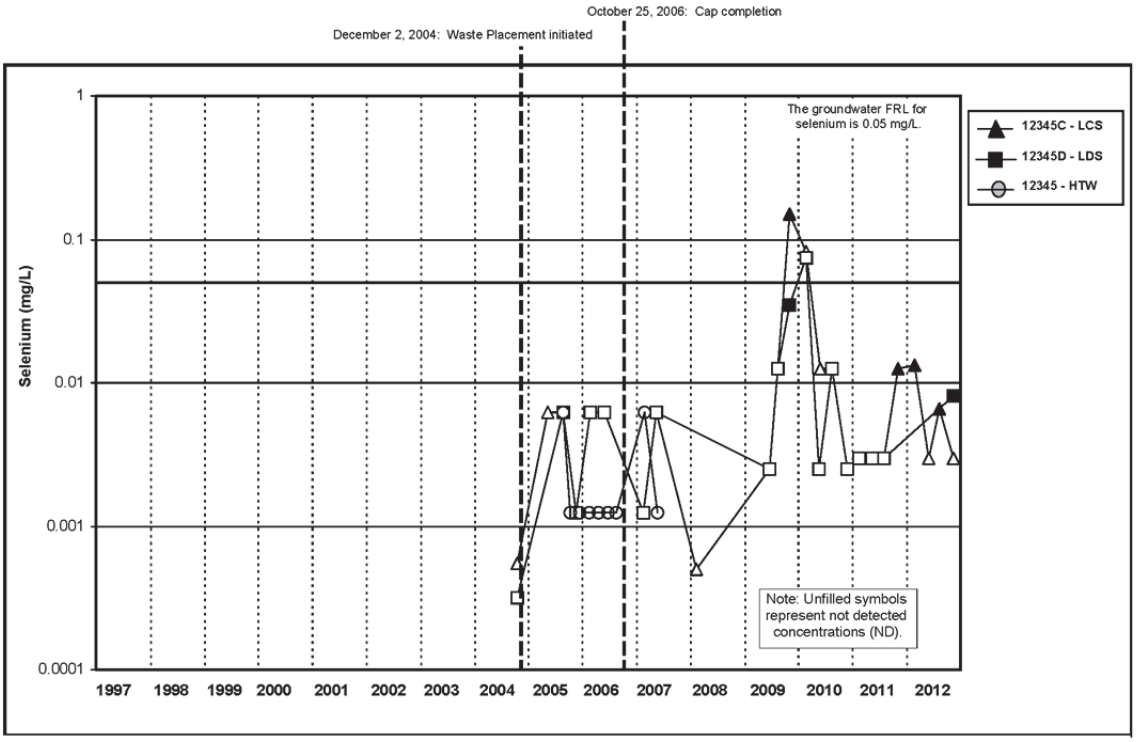


Figure A.5.8–28A. Cell 8 Selenium Concentration vs. Time Plot for LCS, LDS, and HTW

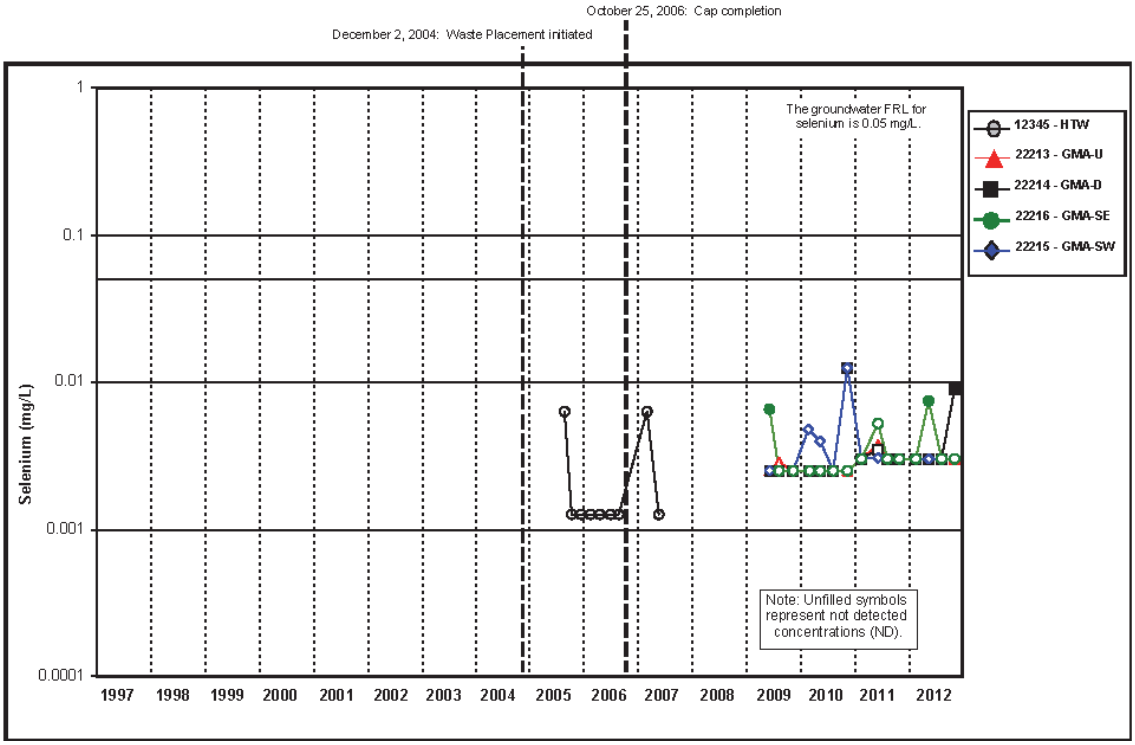


Figure A.5.8–28B. Cell 8 Selenium Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

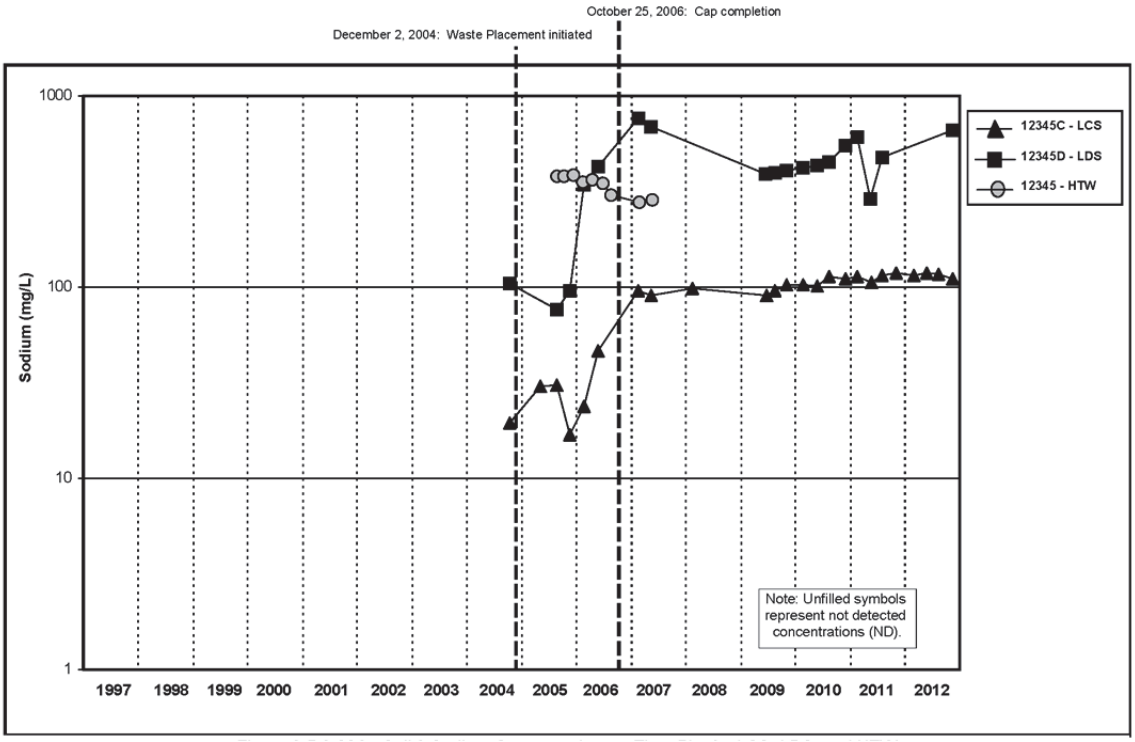


Figure A.5.8–29A. Cell 8 Sodium Concentration vs. Time Plot for LCS, LDS, and HTW

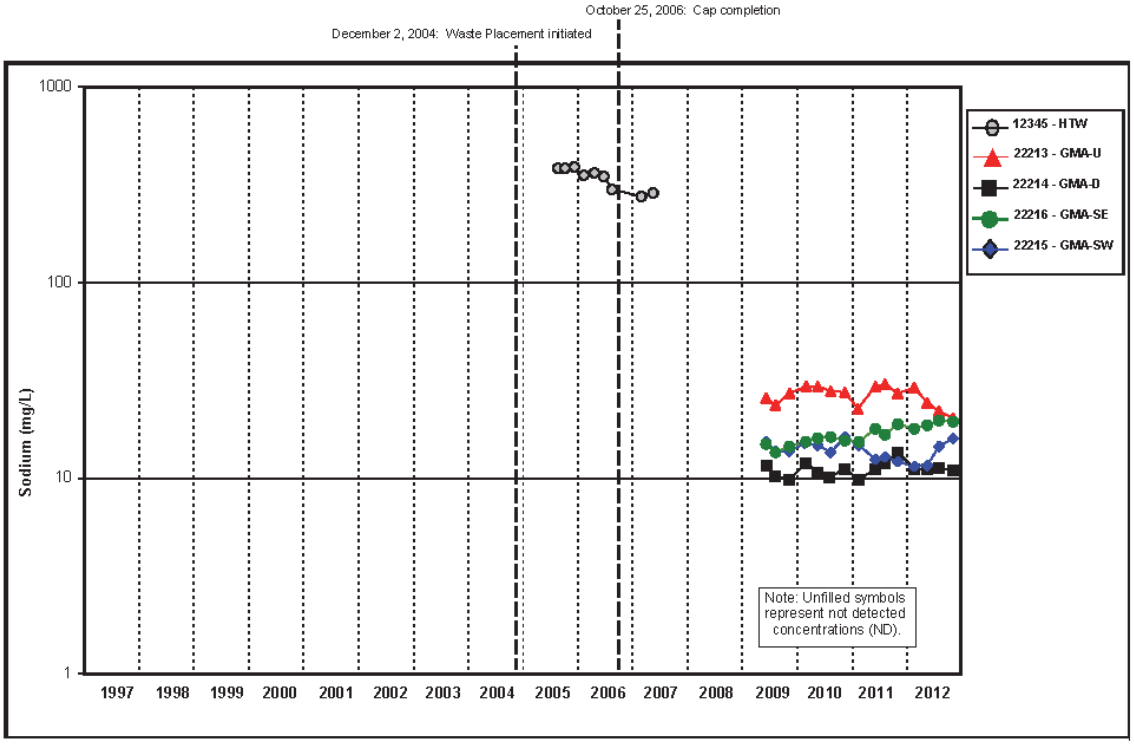


Figure A.5.8–29B. Cell 8 Sodium Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

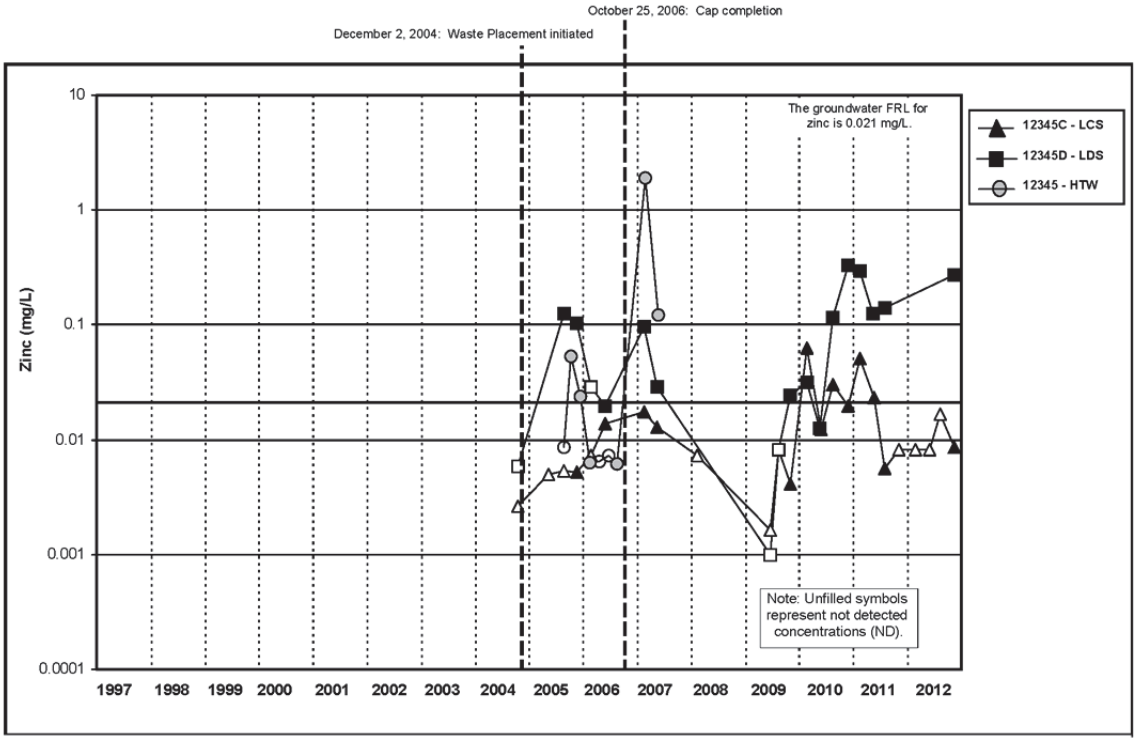


Figure A.5.8–30A. Cell 8 Zinc Concentration vs. Time Plot for LCS, LDS, and HTW

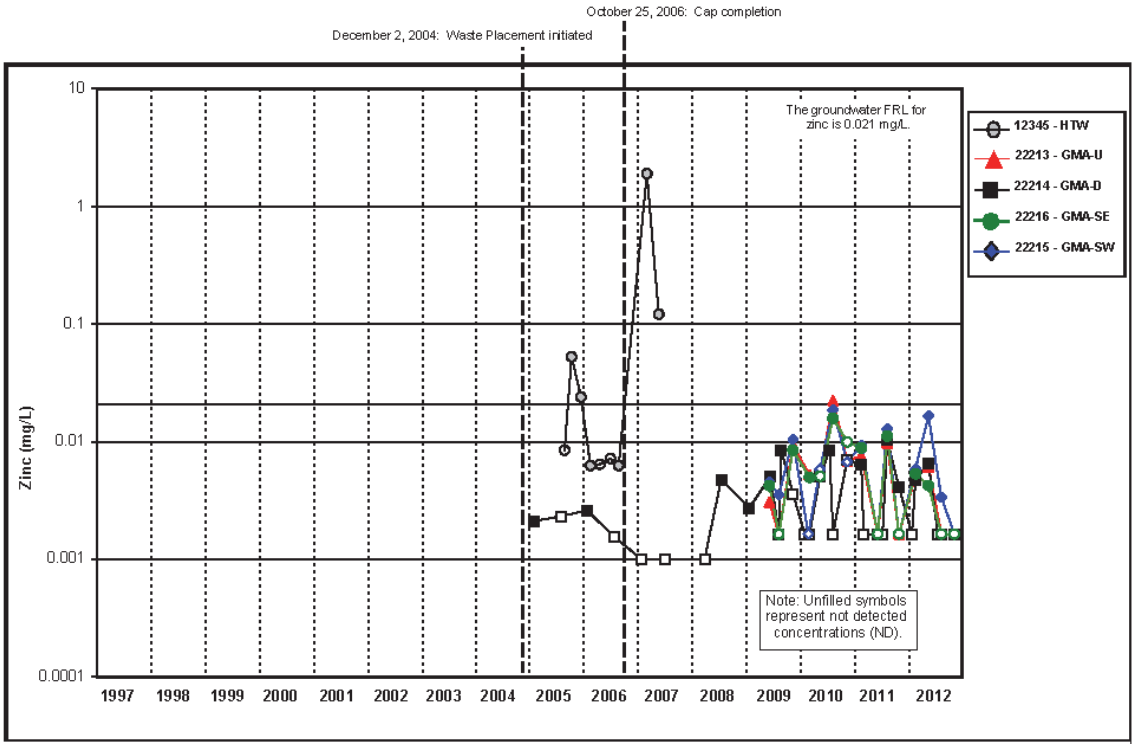


Figure A.5.8–30B. Cell 8 Zinc Concentration vs. Time Plot for HTW, GMA-U, GMA-D, GMA-SE, and GMA-SW Wells

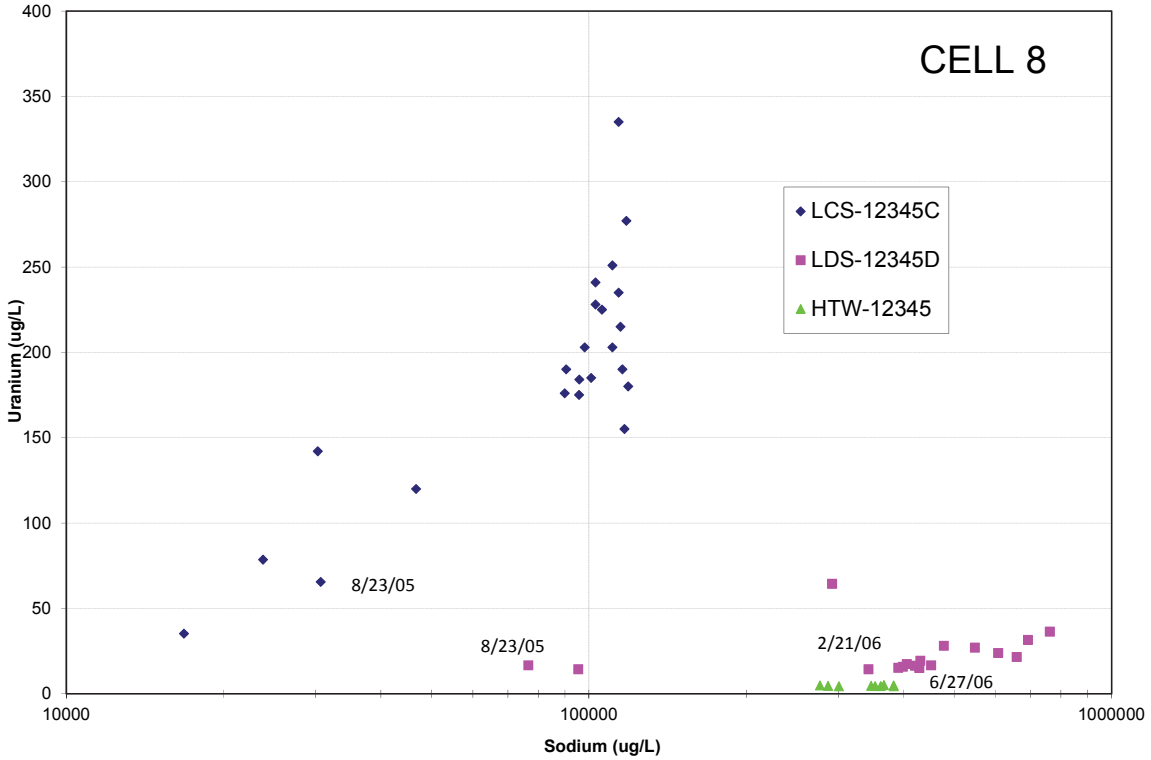


Figure A.5.8–31. Cell 8 Bivariate Plot for Uranium and Sodium

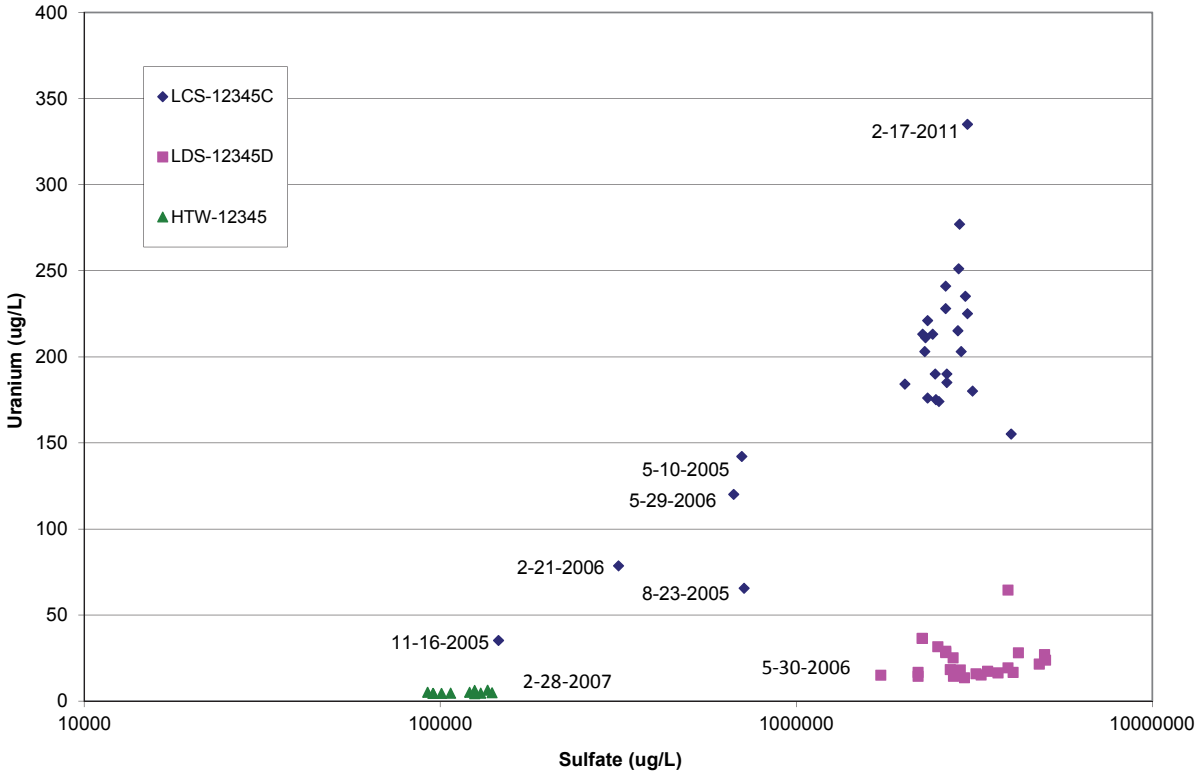


Figure A.5.8–32. Cell 8 Bivariate Plot for Uranium and Sulfate

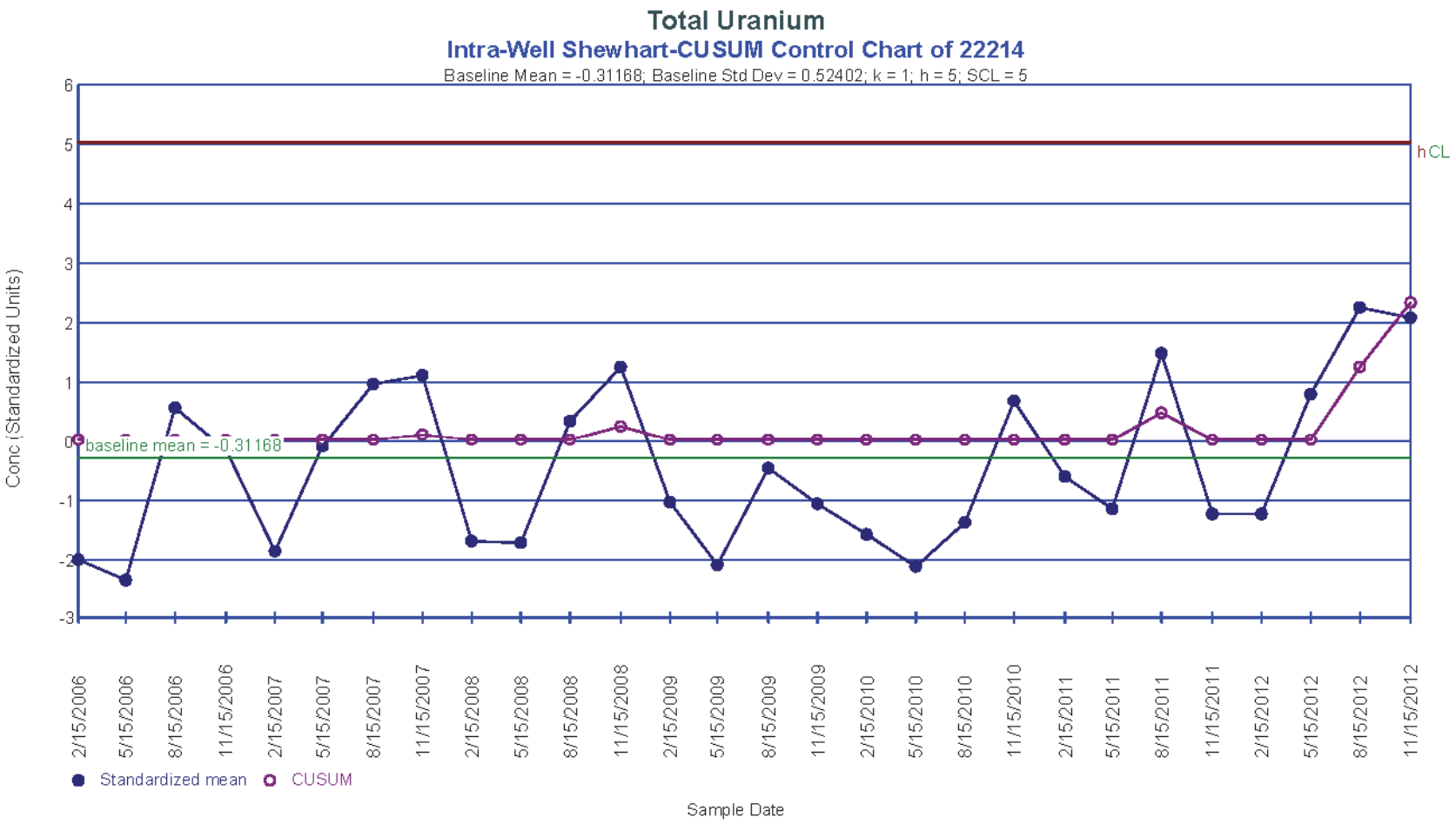


Figure A.5.8–33. Intra-Well Shewhart-CUSUM Control Chart (Total Uranium 22214)

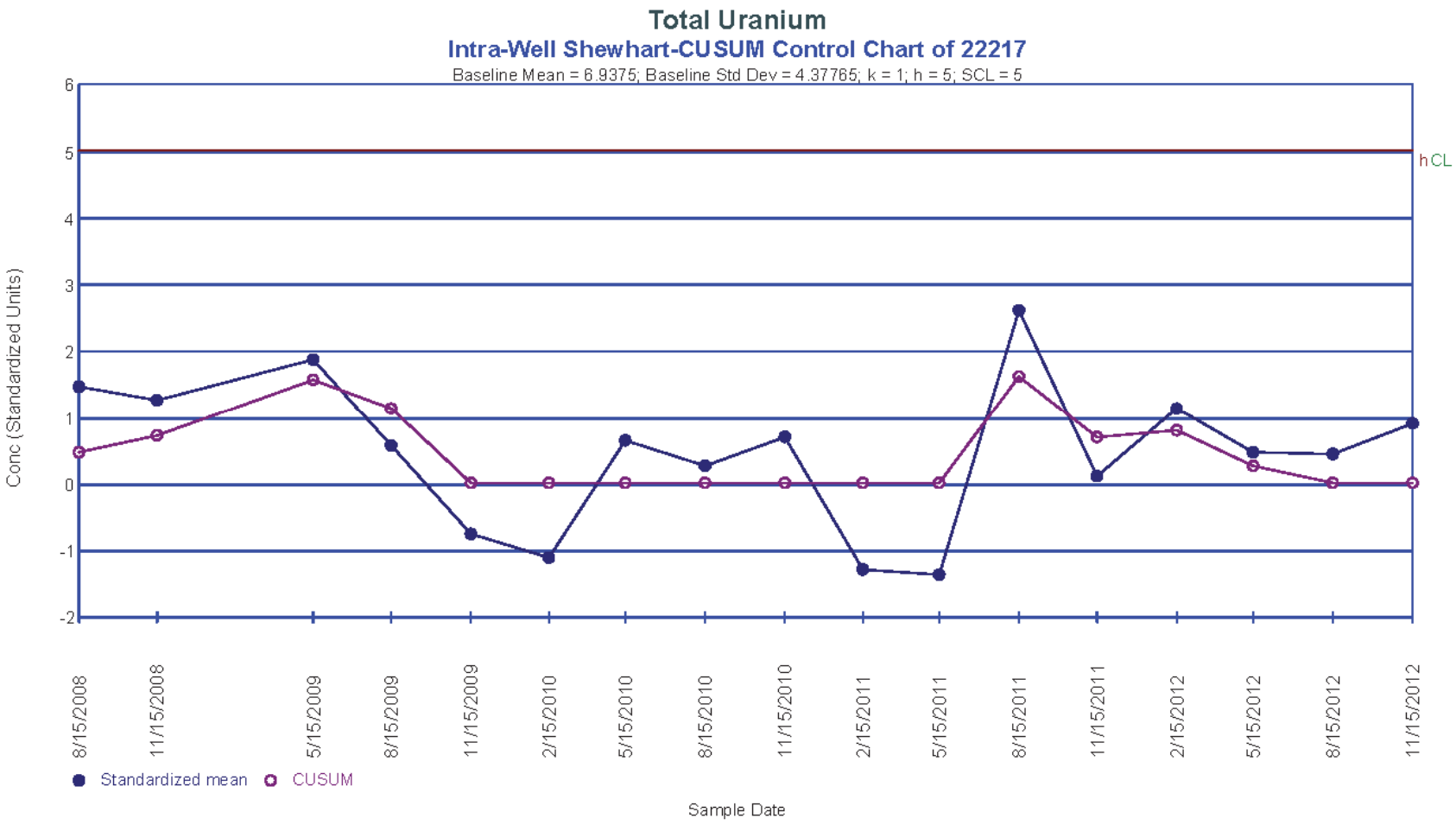


Figure A.5.8–34. Intra-Well Shewhart-CUSUM Control Chart (Total Uranium 22217)

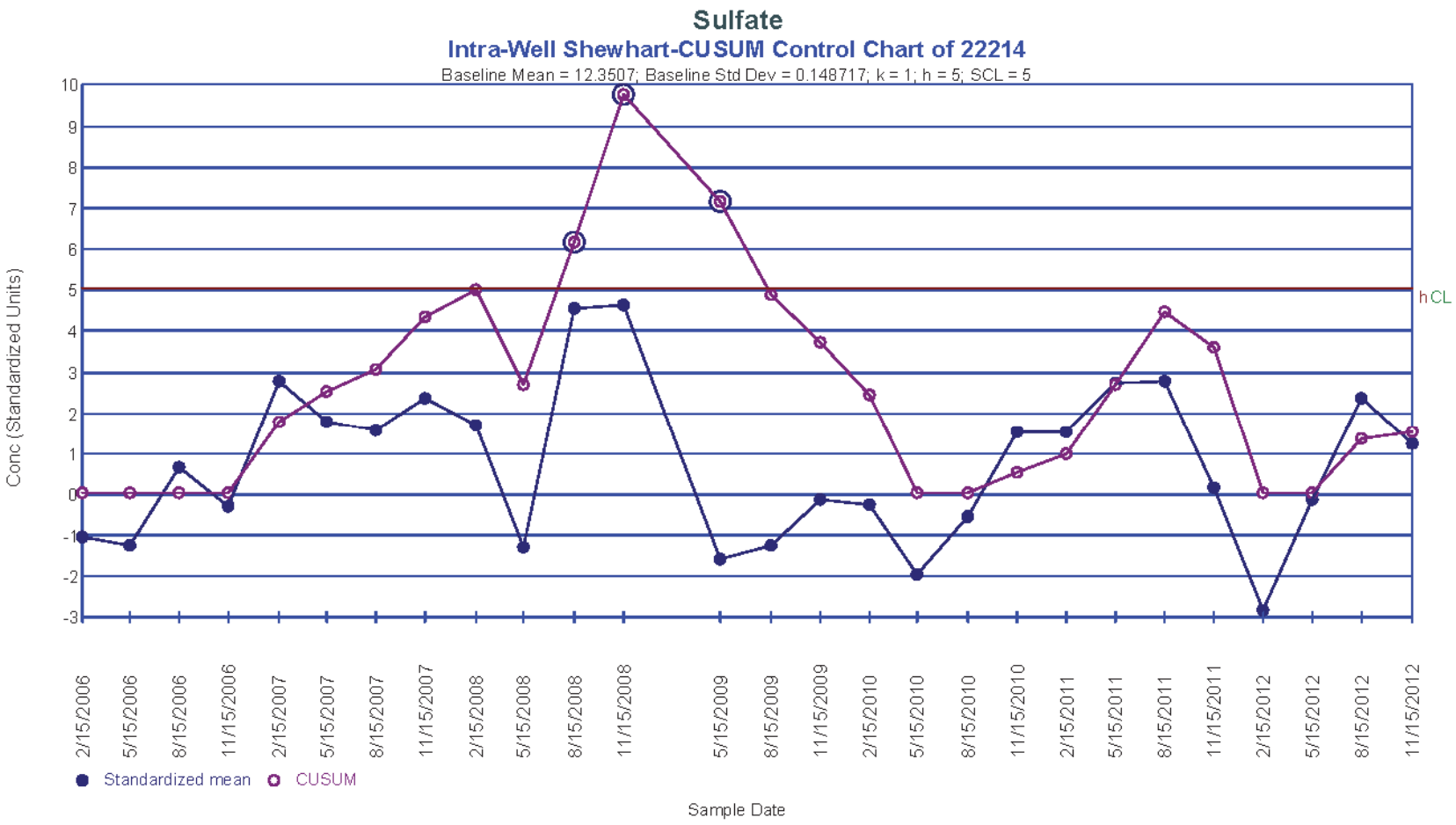


Figure A.5.8–35. Intra-Well Shewhart-CUSUM Control Chart (Sulfate 22214)

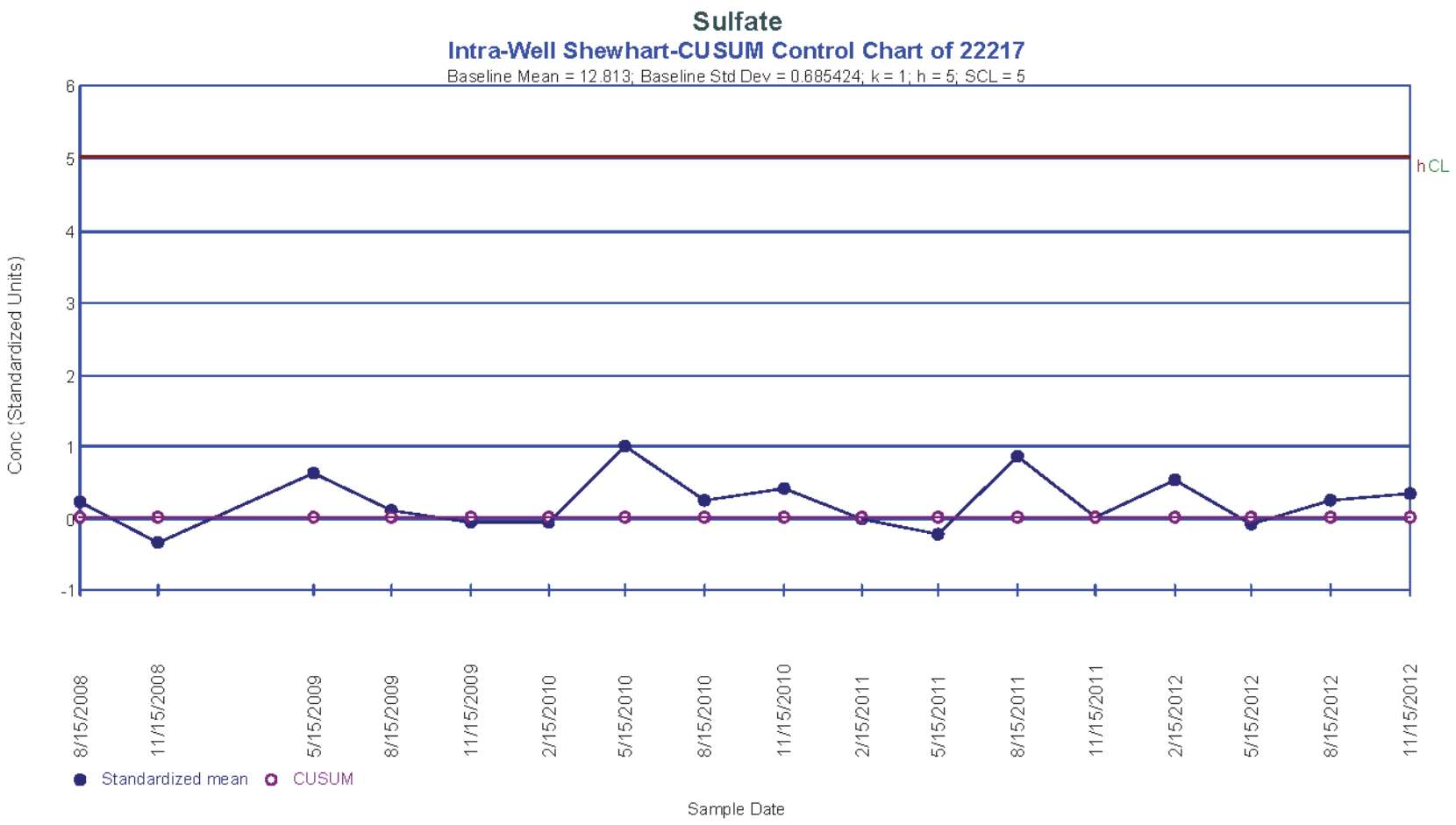


Figure A.5.8–36. Intra-Well Shewhart-CUSUM Control Chart (Sulfate 22217)

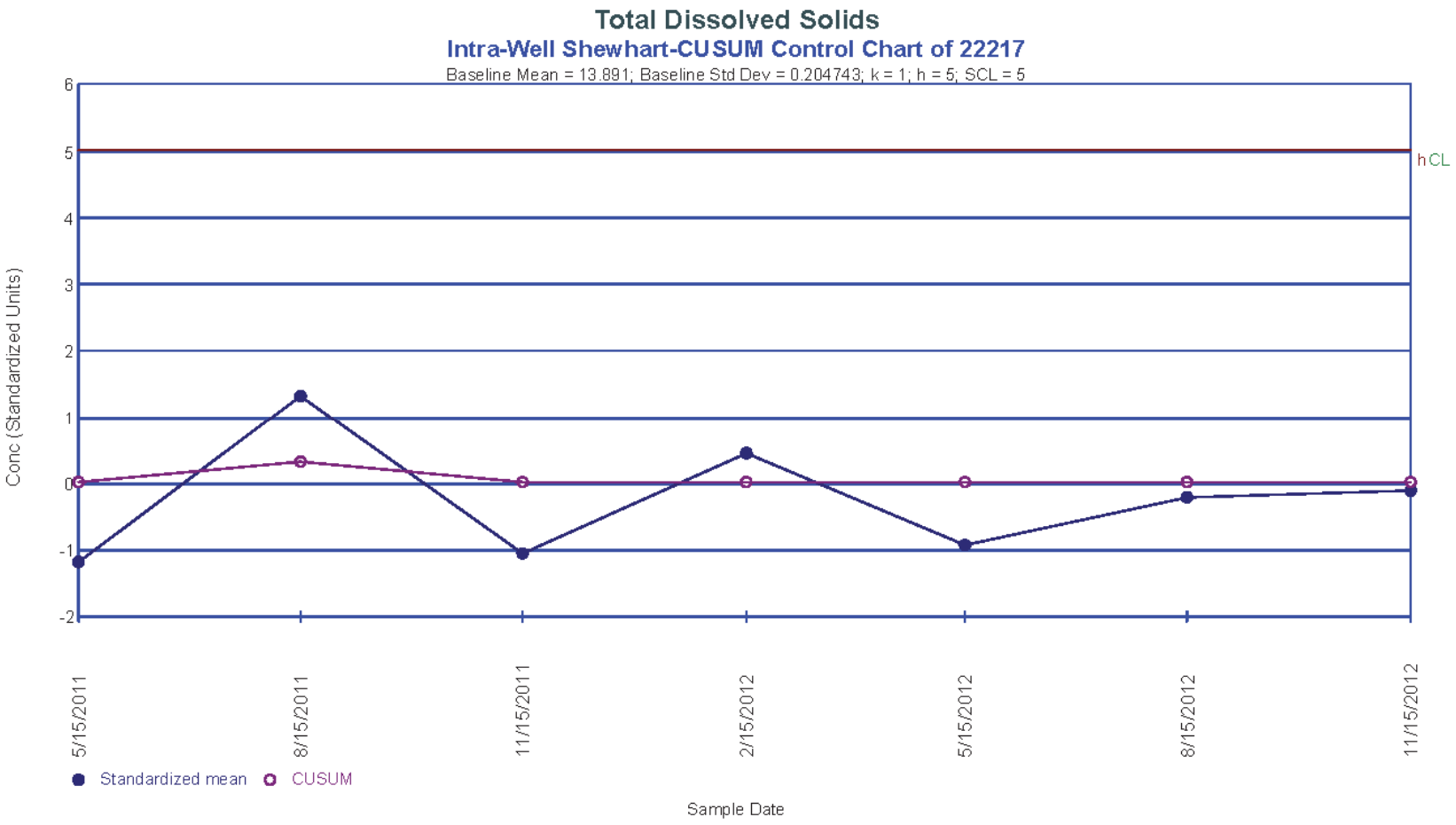


Figure A.5.8–37. Intra-Well Shewhart-CUSUM Control Chart (Total Dissolved Solids 22217)

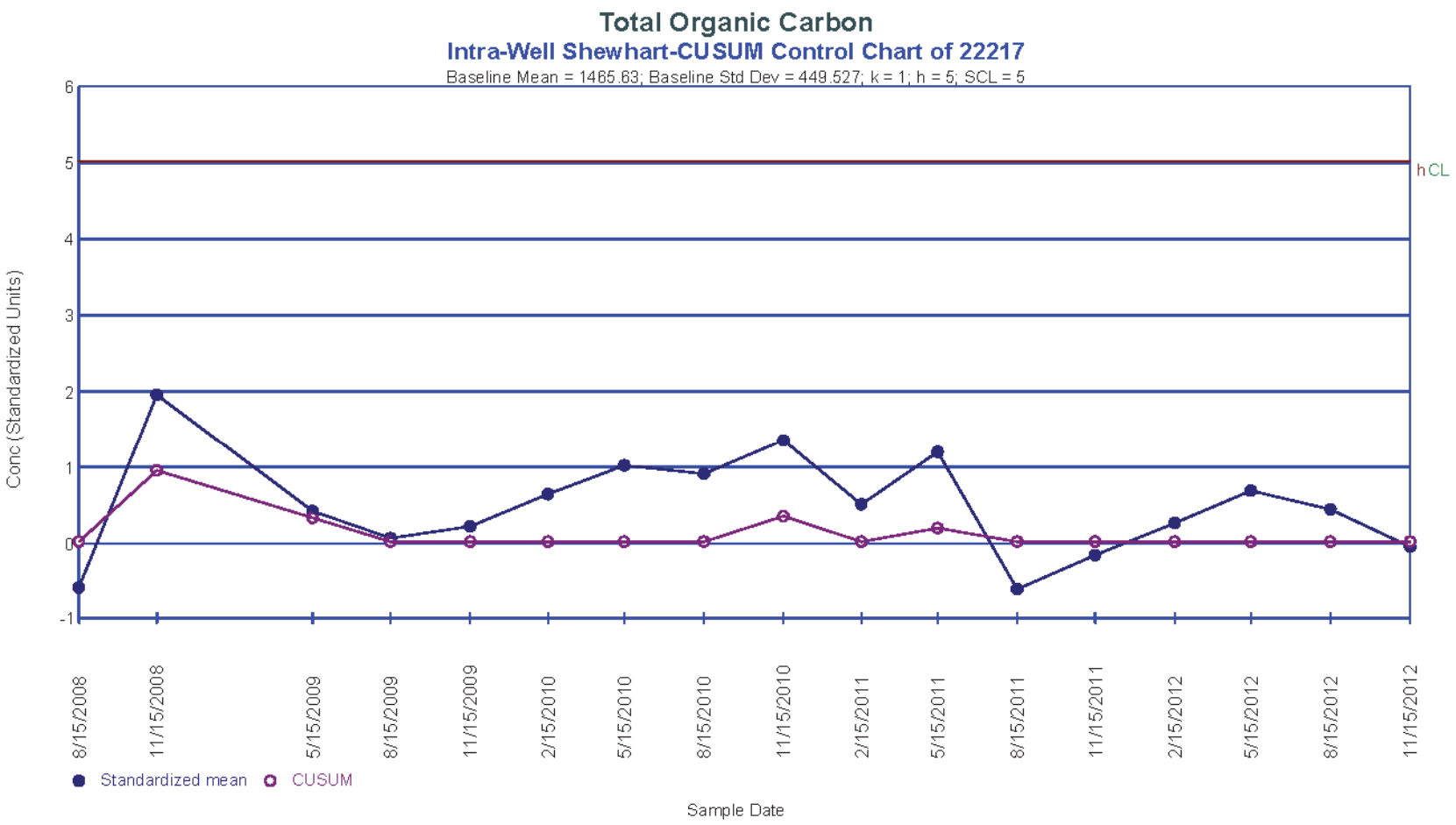


Figure A.5.8–38. Intra-Well Shewhart-CUSUM Control Chart (Total Organic Carbon 22217)

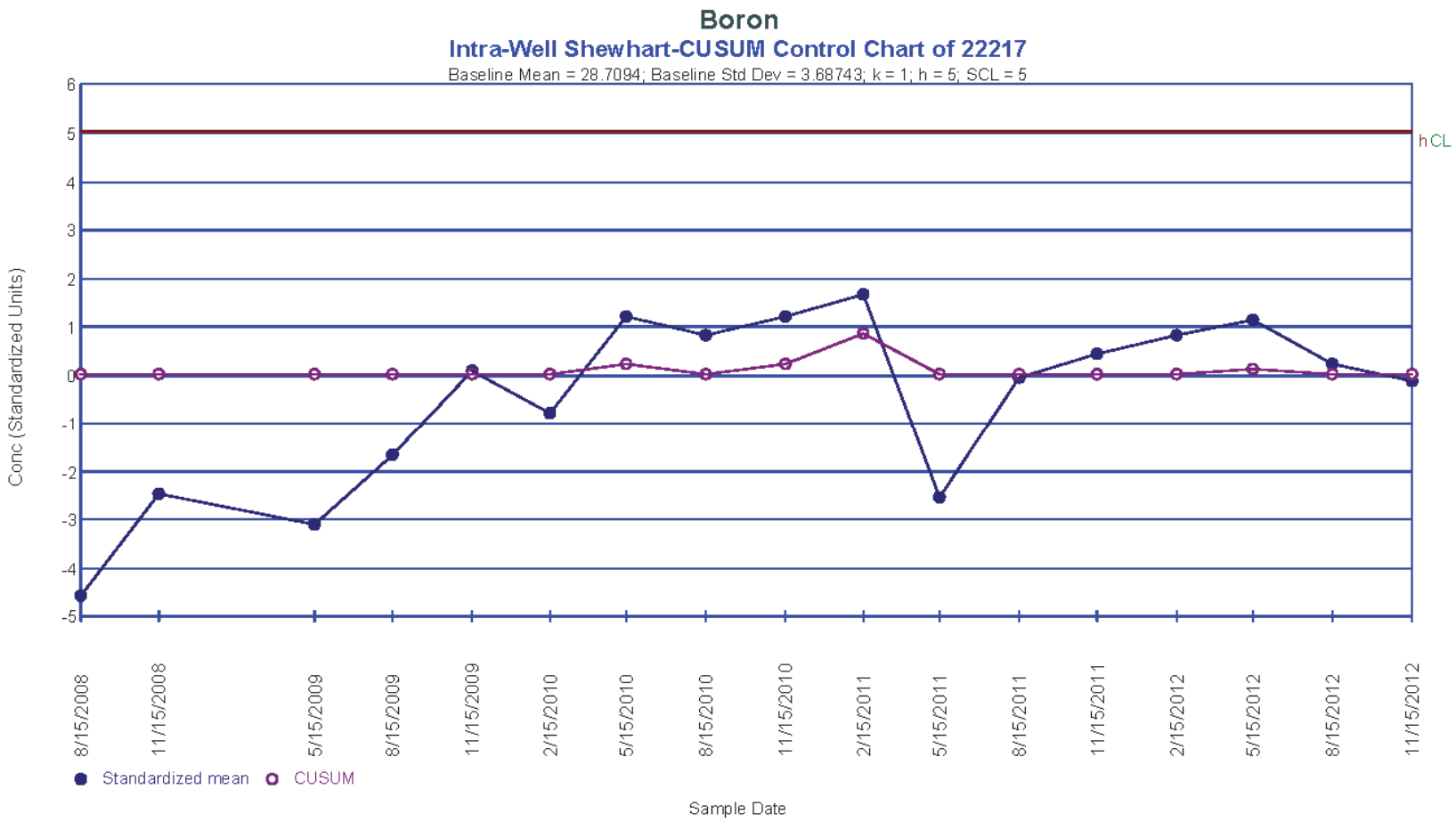


Figure A.5.8–39. Intra-Well Shewhart-CUSUM Control Chart (Boron 22217)

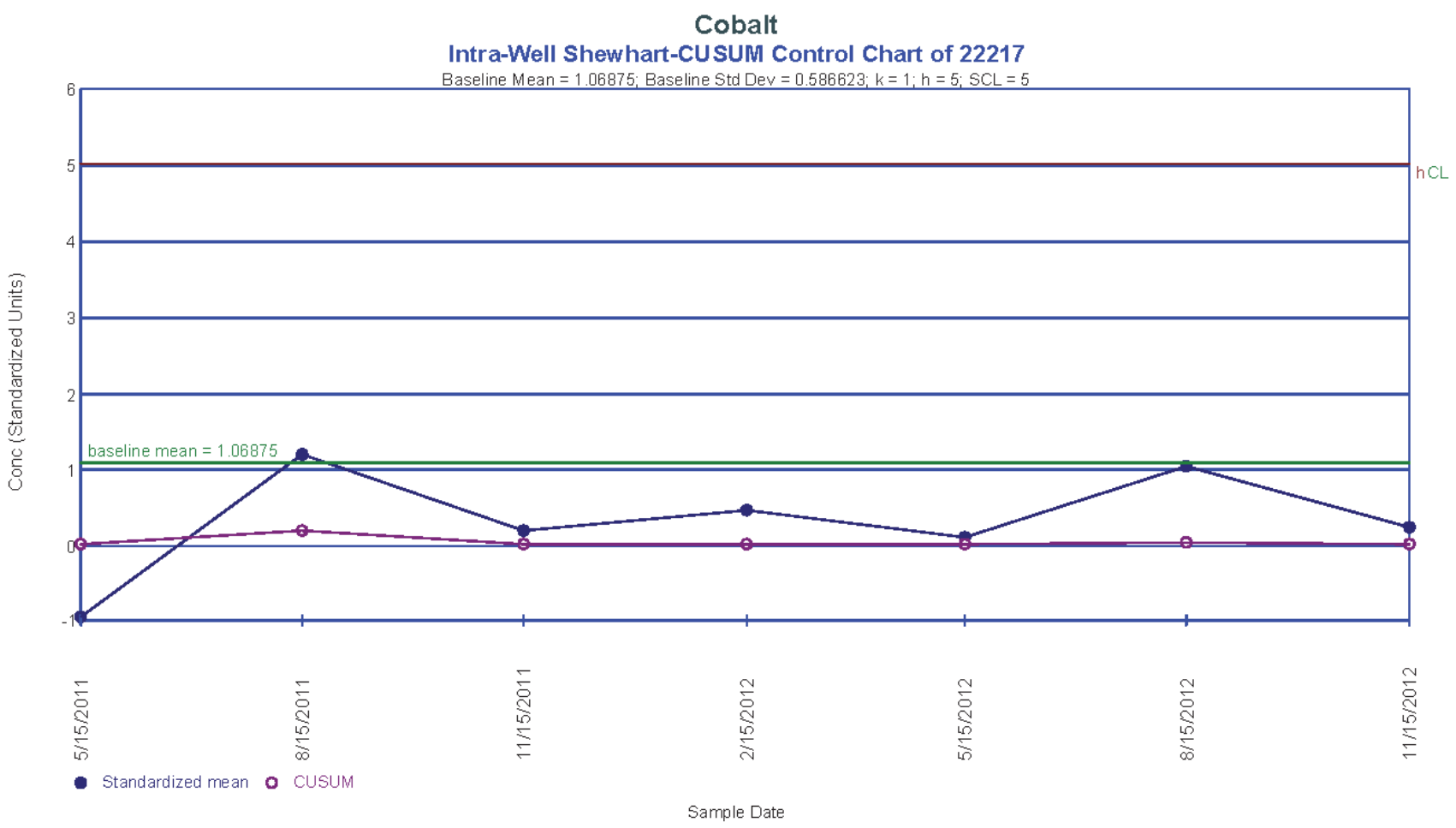


Figure A.5.8–40. Intra-Well Shewhart-CUSUM Control Chart (Cobalt 22217)

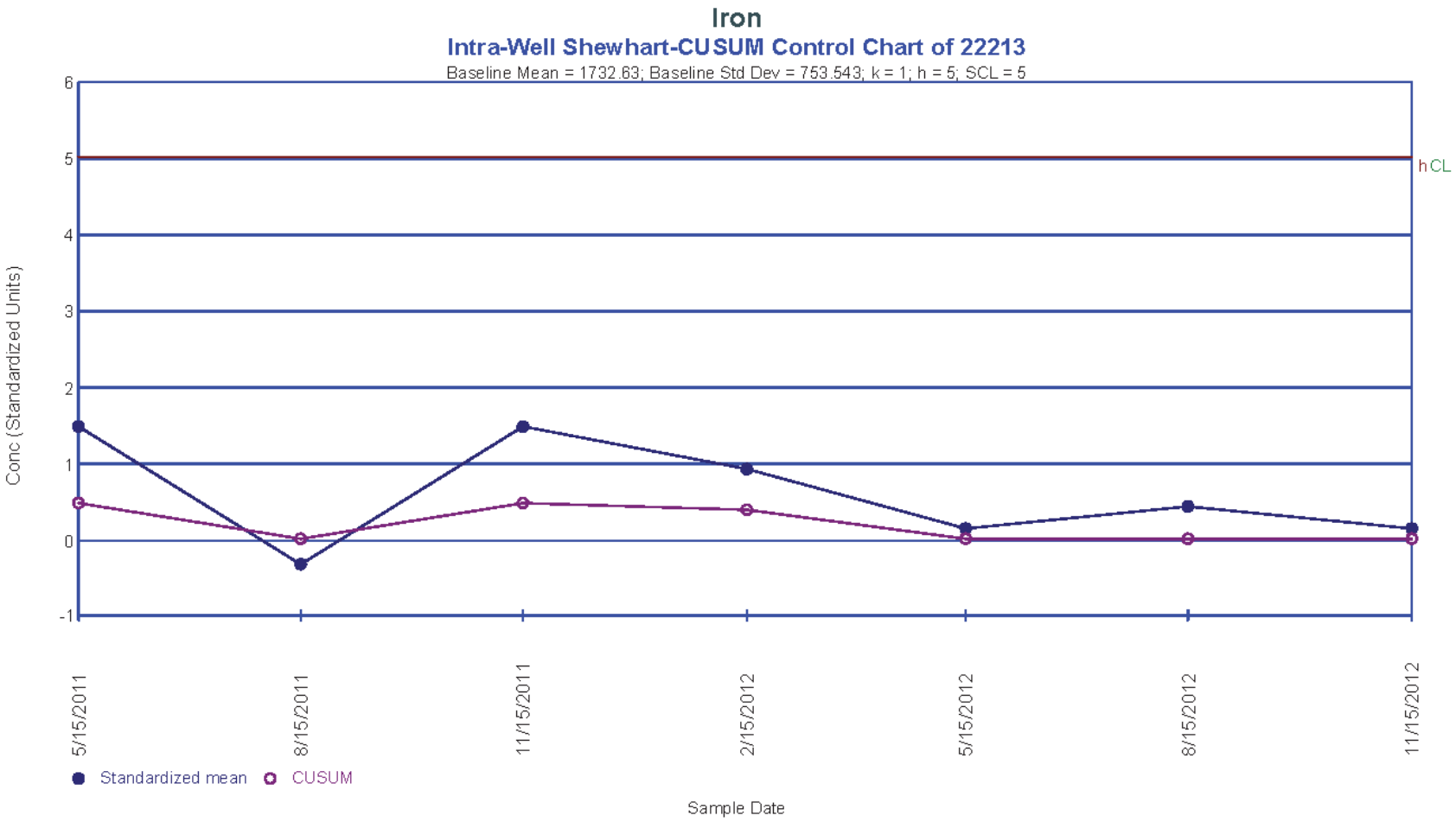


Figure A.5.8–41. Intra-Well Shewhart-CUSUM Control Chart (Iron 22213)

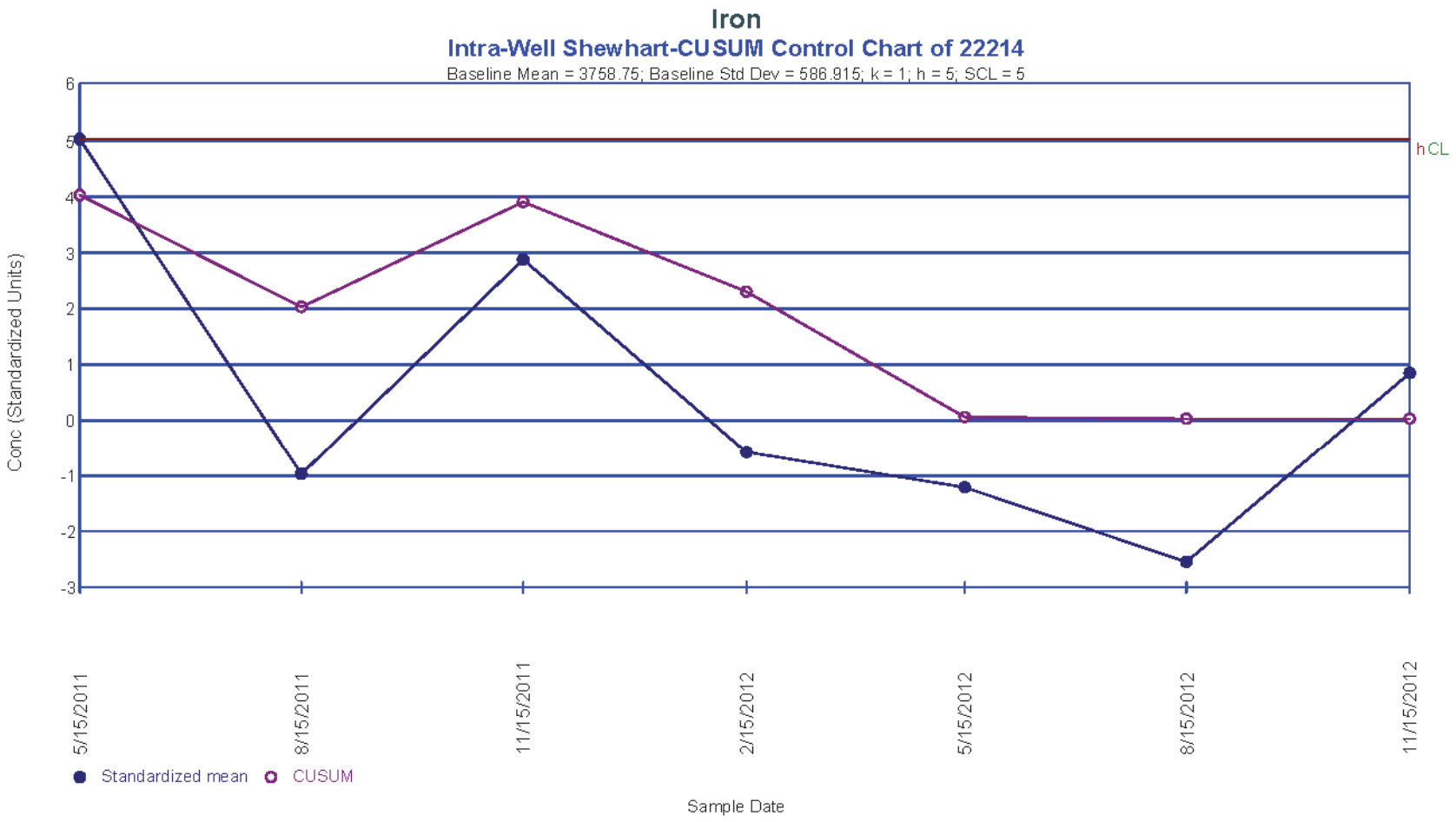


Figure A.5.8–42. Intra-Well Shewhart-CUSUM Control Chart (Iron 22214)

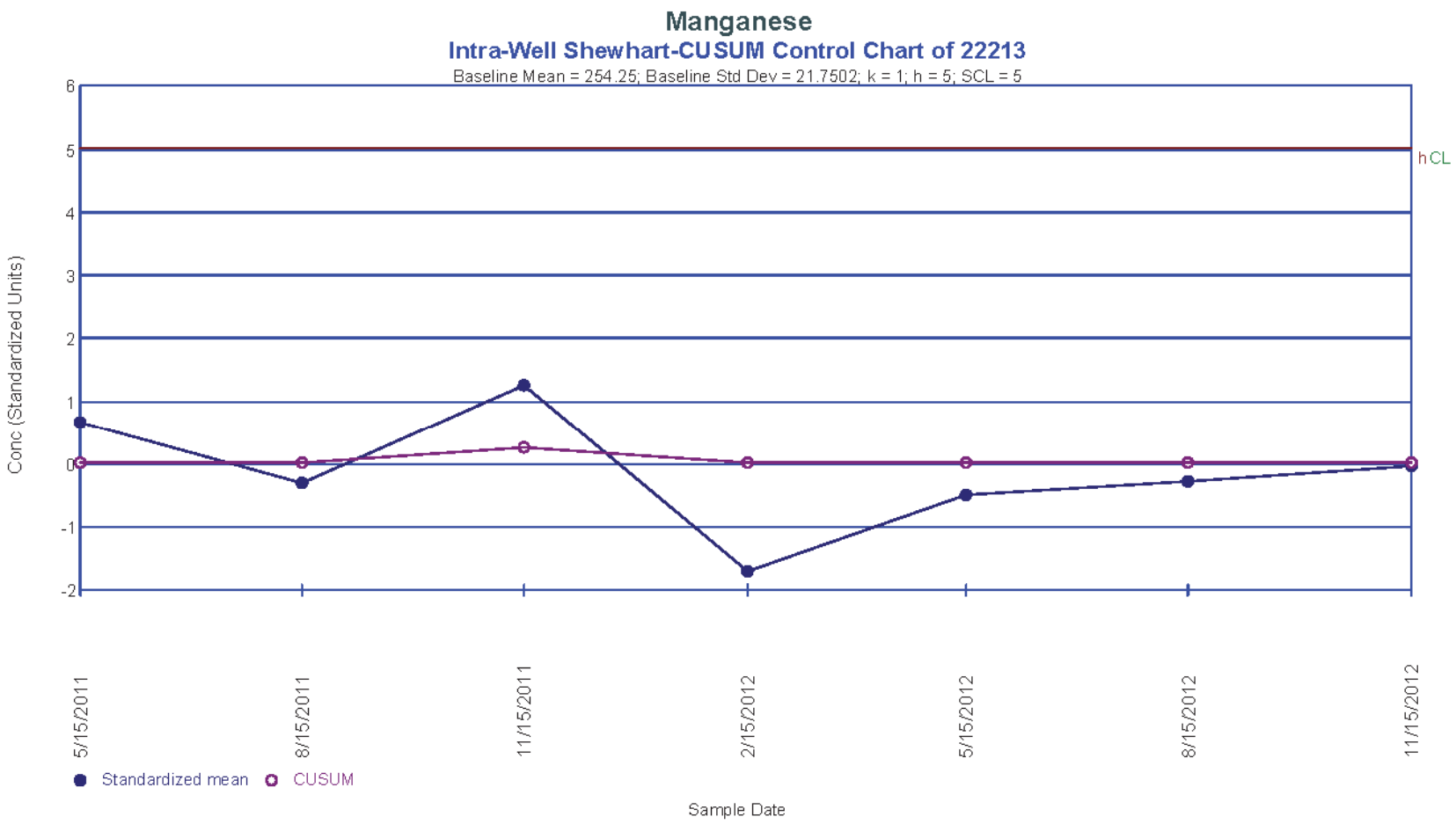


Figure A.5.8–43. Intra-Well Shewhart-CUSUM Control Chart (Manganese 22213)

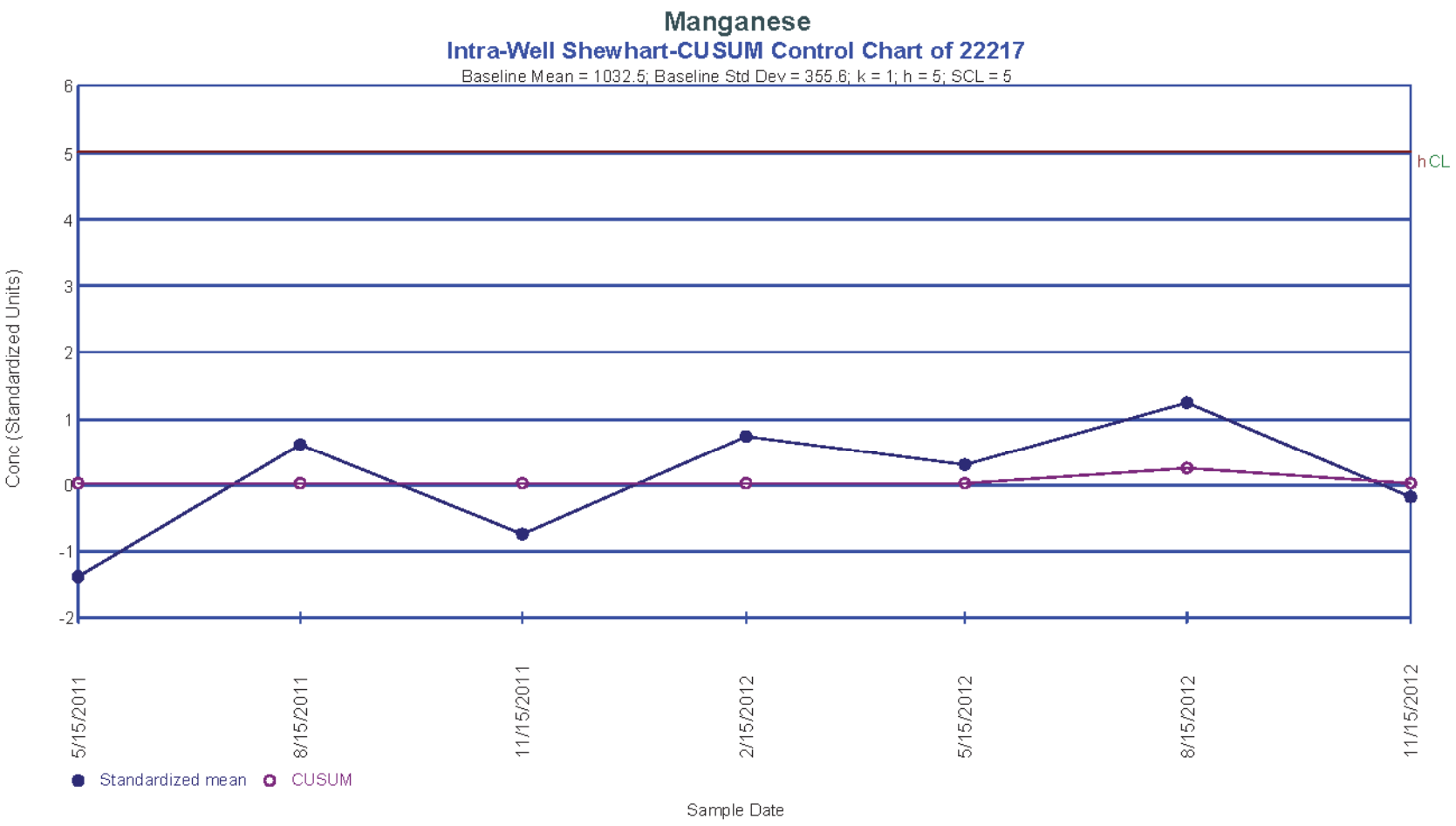


Figure A.5.8–44. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22217)

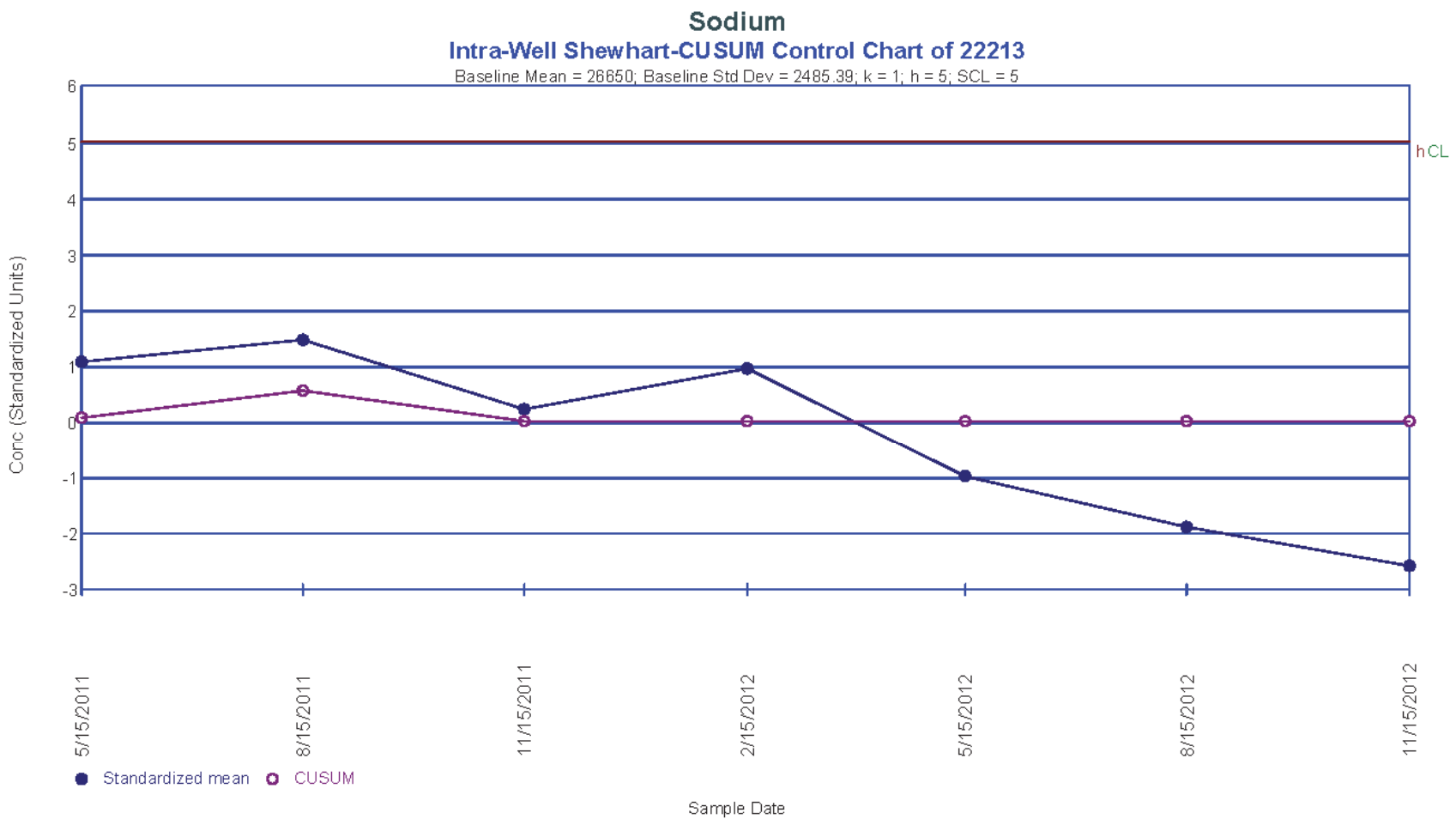


Figure A.5.8–45. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22213)

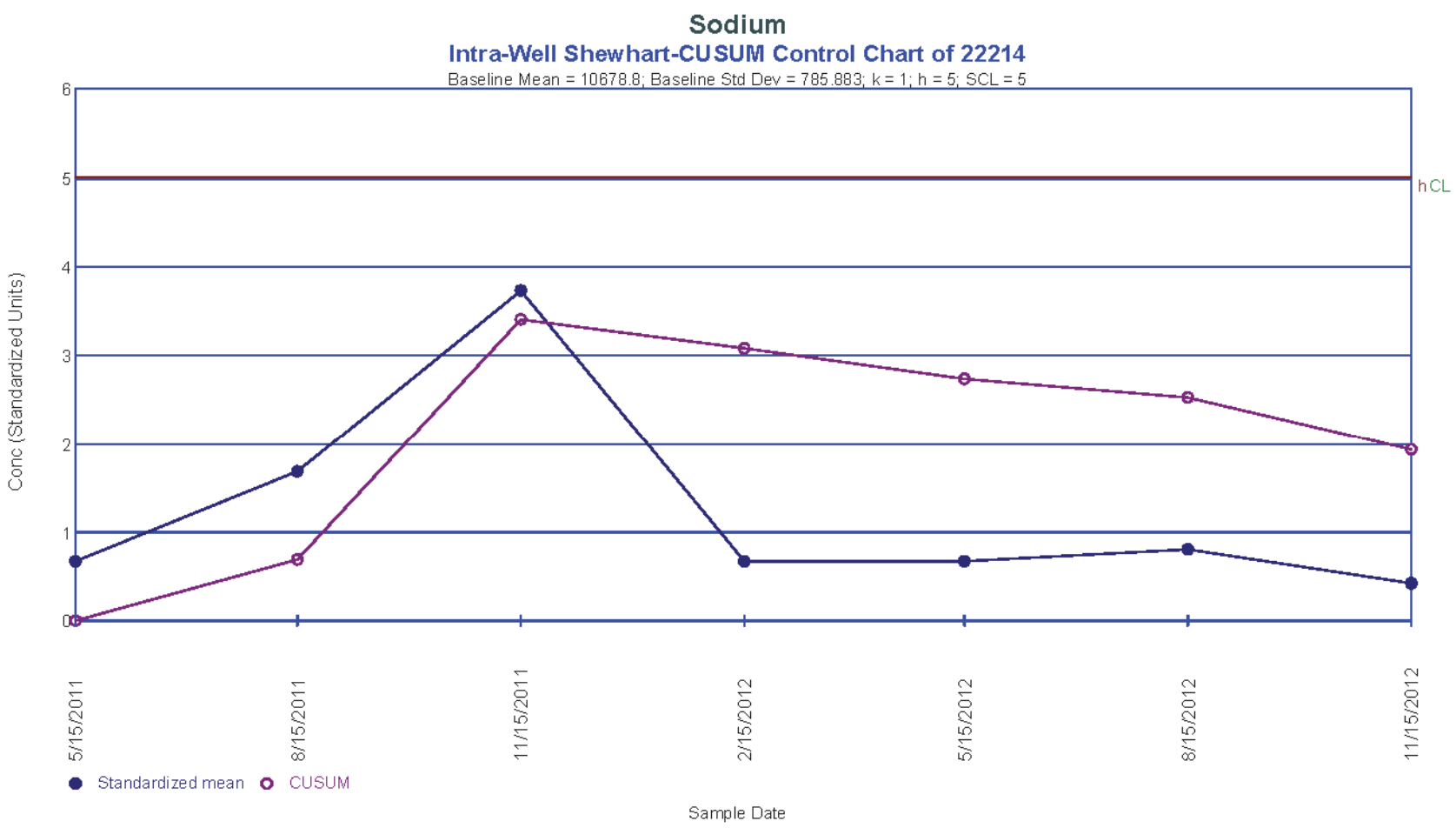


Figure A.5.8–46. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22214)

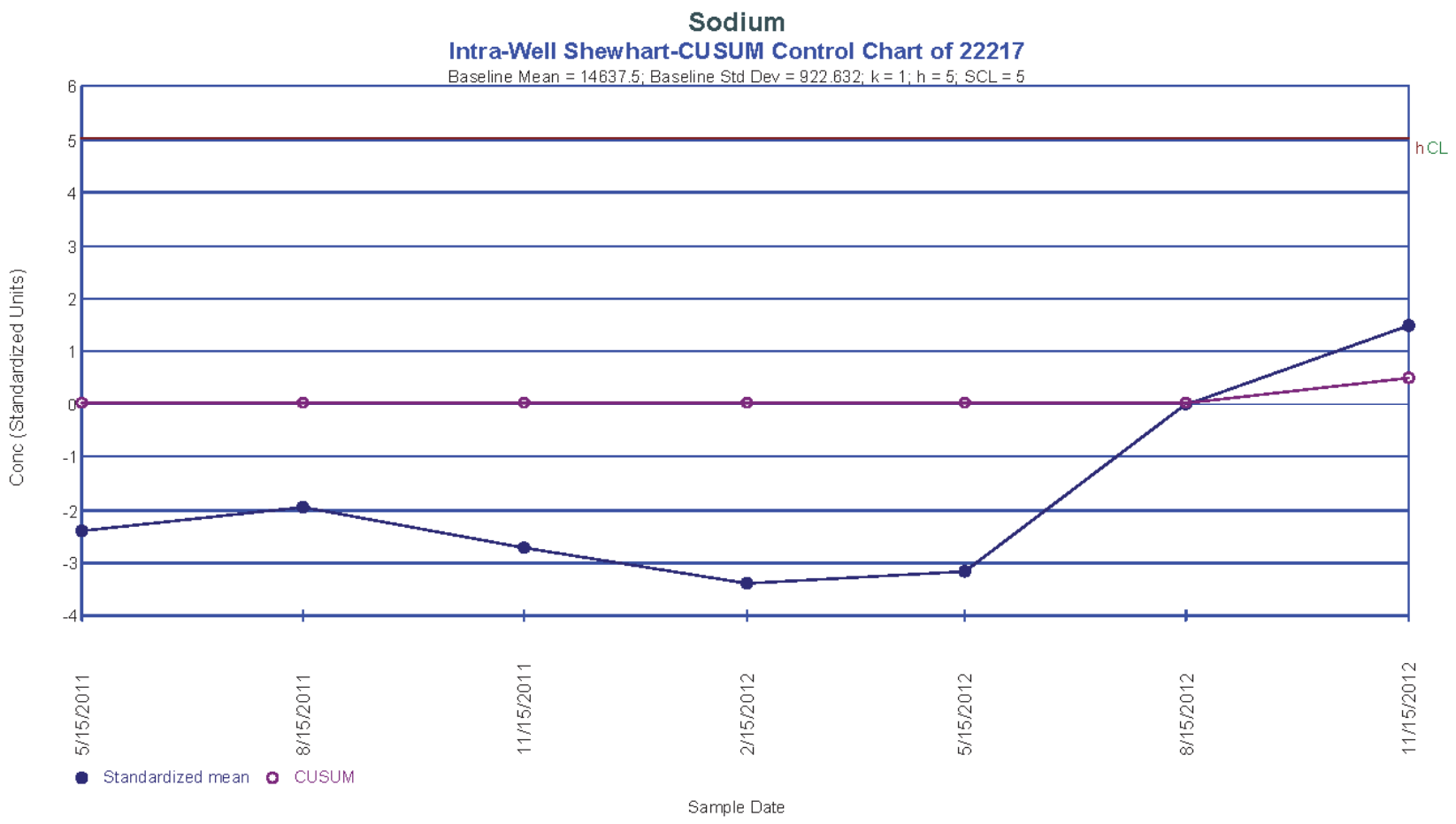


Figure A.5.8–47. Intra-Well Shewhart-CUSUM Control Chart (Sodium 22217)

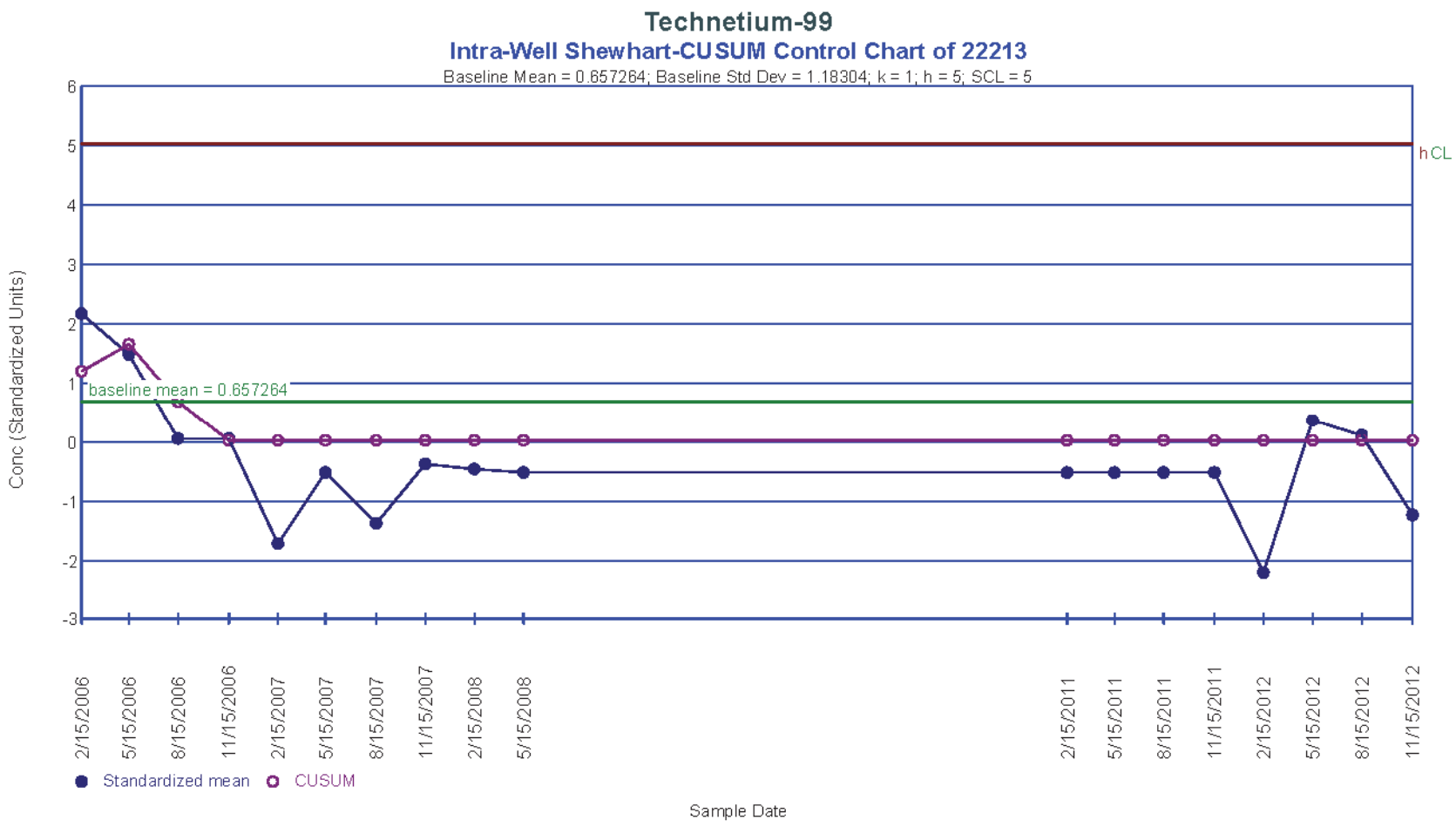


Figure A.5.8–48. Intra-Well Shewhart-CUSUM Control Chart (Technetium-99 22213)

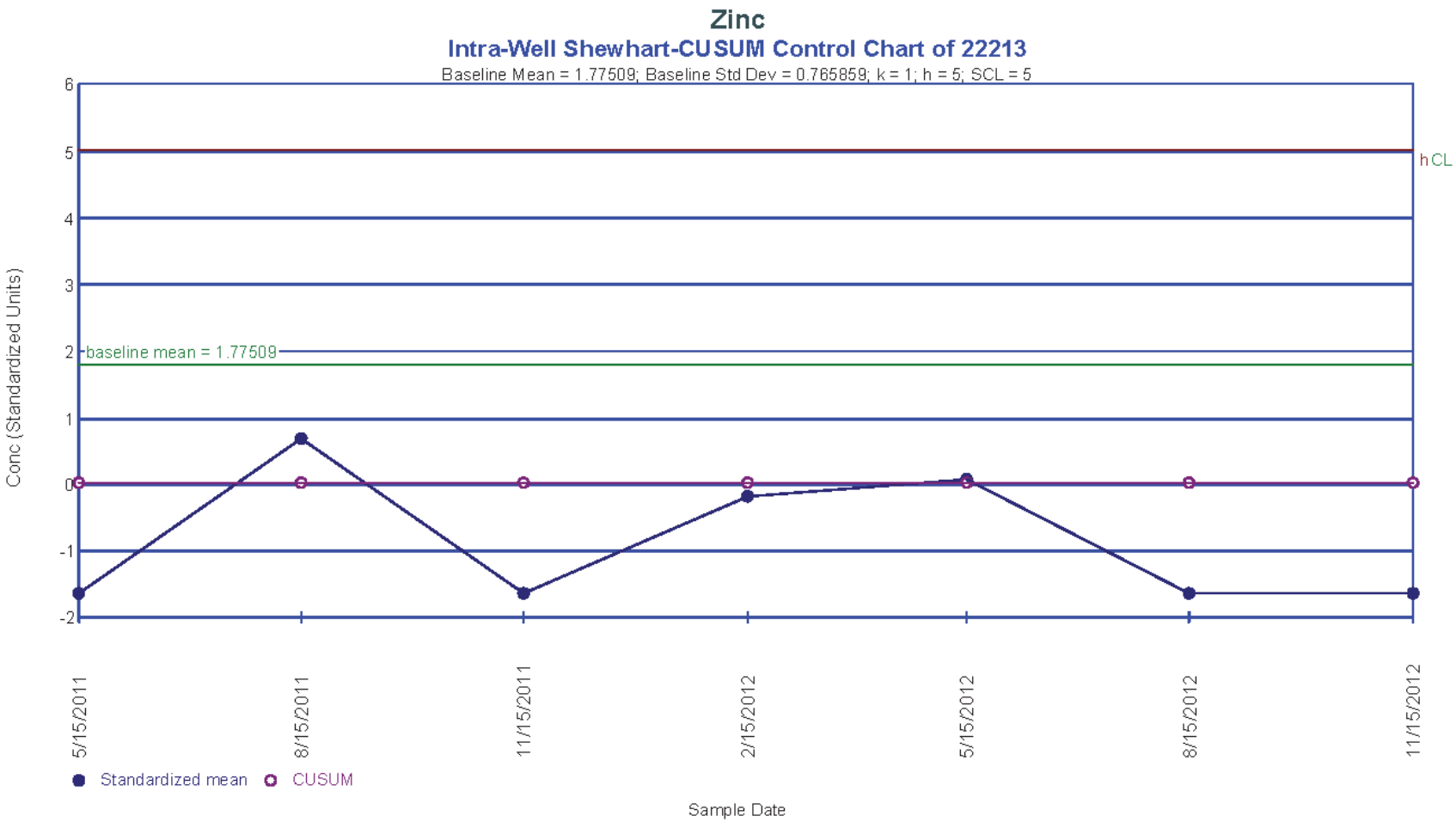


Figure A.5.8–49. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22213)

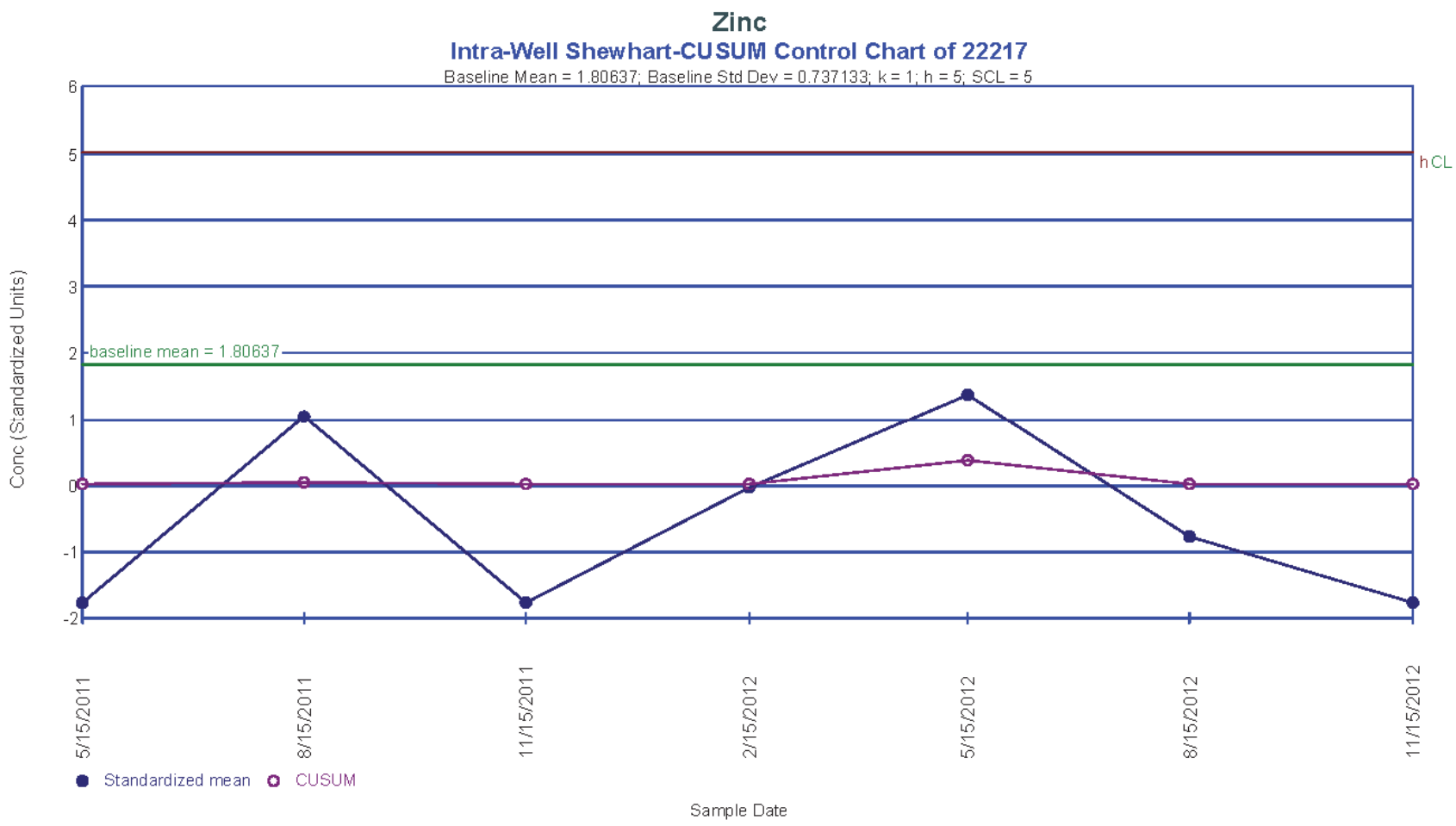


Figure A.5.8–50. Intra-Well Shewhart-CUSUM Control Chart (Zinc 22217)